7. INTERNATIONAL EARTH SCIENCE COLLOQUIUM on the AEGEAN REGION

ABSTRACT BOOK PROGRAM & NOTEBOOK
7-11 October 2019

DOKUZ EYLÜL UNIVERSITY
DESEM CONFERENCE CENTRE, Alsancak - İZMİR / TÜRKİYE
www.iesca.deu.edu.tr & iesca@deu.edu.tr
WELCOME

Dear colleagues,

On behalf of the organizing committee, I am honored to welcome you to the seventh meeting of the International Earth Science Colloquium on the Aegean Region, IESCA-2019, which is held by Dokuz Eylül University in Izmir.

The IESCA meetings aim to gather the earth scientists from different countries and fields to share their new geological/geophysical studies on the Aegean and environs. The IESCA was first organized by the Earth Sciences Faculty of Ege University (İzmir, Turkey) with the chairmanship of Prof. Dr. Erol İzdar in 1977. The following IESCA meetings were then organized in 1990 by Prof. Dr. Eran Nakoman, in 1995 by Prof. Dr. Altan Gümüş, in 2000 by Prof. Dr. Özcan Dora, in 2005 by Prof. Dr. Eran Nakoman, and finally in 2012 by Prof. Dr. Cahit Helvacı.

The scope of the last IESCA meetings has been broadened to a wide region across the Mediterranean, exceeding the Aegean region. For the IESCA-2019 meeting, 188 abstract and/or full-texts have been submitted from 16 different countries. 134 oral and 54 poster presentations have been scheduled to be presented in the frame of 18 scientific sessions which are grouped under the main topics of “Regional Geology of the Aegean and the Environs”, “Economic Geology” and “Applied Geology & Geophysics”. The participants will be invited to publish their full-texts in a proceeding book or to publish their works in peer-review special issues in international journals in following days.

The IESCA meetings are traditionally accompanied by invited speeches/workshops and field trips. Hence, we have cordially invited 10 scientists who are experts in their fields to give speeches on their study areas. We wish to thank our invited speakers Mr. Özer Balkaş, Dr. Erdin Bozkurt, Dr. Massimo Chiaradia, Dr. Cahit Helvacı, Dr. Maud J.M. Meijers, Dr. Aral I. Okay, Dr. Martin R. Palmer, Dr. Dejan Prelevic, Dr. Yücel Yılmaz, and Dr. Özdoğan Yılmaz. I would like to thank them for kindly accepting our invitation. A 2-days field trip has also been planned as a post-colloquium technical excursion. On the first day, we aim to visit Neoproterozoic to Palaeozoic stratigraphy and Early Cambrian high-pressure metamorphic records in the Menderes Massif. On the second day, the low-angle detachment fault, responsible for the Miocene exhumation of the Menderes Massif, the Miocene supra-detachment sedimentary units, the Gediz graben and the Quaternary basaltic volcanism of Kula will be visited.

I wish to thank the organizing and the scientific committee of the IESCA-2019, Dokuz Eylül University Rectorate for their supports and our sponsors including Koza Gold Corporation, Esan Mining, Likya Minerals, Chamber of Geological Engineers, Tüprag A.Ş., Turkish Academy of Science, Anakaya A.Ş. and Eföl Engineering, as well as to all participants. I hope that the participants will learn much about the geology of the Aegean and Mediterranean regions, and enthusiastically discuss the problems with world leading scientists to establish new collaborations and friendship.

Dr. E. Yalçın ERSOY
Chairmann of the IESCA-2019
IESCA-2019 ORGANIZING TEAM

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Alexis Plunder - Sorbonne University, Paris, France
Ali E. Aksu - Memorial State University of Newfoundland, Canada
Ali Reza D. Dehkordi - Shahrekord University, Shahr-e Kord, Iran
Alper Baba - İzmir Institute of Technology, İzmir, Turkey
Amaury Pourteau - Curtin University, Perth, Australia
André Poisson - Paris-Sud University, Orsay, France
Andrea Hampel - Leibniz University, Hannover, Germany
Aral Okay - Istanbul Technical University, Istanbul, Turkey
Aysen Öğüt Özel - Istanbul University, Istanbul, Turkey
Atiye Tuğrul - İstanbul Technical University, İstanbul, Turkey
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Bulent Tezkan - University of Cologne, Cologne, Germany
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& Belgrade University, Faculty of Mining and Geology, Belgrad, Serbia
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Ivana Vasiljević - University of Belgrade, Serbia
Jean-Pierre Brun - University of Rennes 1, Rennes, France
Julian Pearce - Cardiff University, Cardiff, United Kingdom
SCIENTIFIC SESSIONS

A. Regional Geology of the Aegean and the Environs

A.1 Tectonics & Palaeogeography of Tethyan Oceans
Conveners: Dr. Alastair ROBERTSON; Dr. Osman PARLAK; Dr. Timur USTAÖMER

A.2 Sedimentology, Biostratigraphy & Palaeoecology of Depocenters in the Eastern Mediterranean Region
Conveners: Dr. Ismail Ömer YILMAZ; Dr. Funda AKGÜN; Dr. Faruk OCAKOĞLU; Dr. Bilal SARI

A.3 Magmatic Geodynamics & Volcanology in the Mediterranean Region
Conveners: Dr. Dejan PRELEVIĆ; Dr. Michele LUSTRINO; Dr. Erkan AYDAR; Dr. Cüneyt AKAL; Dr. Altduğ HASÖZBEK

A.4 Cenozoic Extensional Tectonics in the Eastern Mediterranean Region
Conveners: Dr. Konstantinos SOUKIS; Dr. Talip GÜNGÖR

A.5 Seismology, Seismotectonics and Geodynamics in the Aegean Region
Conveners: Dr. Anastasia KIRATZI; Dr. Zafeiria ROUMELIOTI; Dr. Semir ÖVER

A.6 Marine Geology and Geophysics
Conveners: Dr. Seda OKAY; Dr. Güney ÇIFÇİ; Dr. Hülya KURT

A.7 Paleomagnetic Investigations & Reconstruction Studies
Conveners: Dr. Nuretdin KAYMAÇTİ; Dr. Mualla CENGİZ ÇİNKU; Dr. Orhan TATAR; Dr. Mümtdaz HISARLI

A.8 Quaternary Events & Climate Change Records across the Eastern Mediterranean Region
Conveners: Dr. Darrel MADDY; Dr. Ökmen SÜMER; Dr. M. Akif SARIKAYA; Dr. M. Sezgül KAYSER-ÖZER

A.9 Geoarcheology & Geological Heritage in Anatolia and Beyond
Conveners: Dr. Ökmen SÜMER; Dr. Nizamettin KAZANCI; Dr. Akan ERSOY; Dr. Mahmut DRAHOR

B. Economic Geology

B.1 Metallic Deposits in the Mediterranean Region
Conveners: Dr. İlknur İLÇİ; Dr. Tolga OYMAN

B.2 Industrial Raw Materials & Gemology in the Mediterranean Region
Conveners: Dr. Muazzez ÇELİK KARAKAYA; Dr. Mümtdaz ÇOLAK; Dr. İbrahim GÜNDOĞAN

B.3 Water & Geothermal Resources in the Eastern Mediterranean Region
Conveners: Dr. Melis SOMAY; Dr. Alper BABA; Dr. Gülteler TARCAN

B.4 Construction Materials
Conveners: Dr. Atiye TUĞRUL; Dr. Tamer TOPAL; Dr. Ali Bahadır YAVUZ

B.5 Fossil Energy Resources and Uranium/Thorium Deposits
Conveners: Dr. Kimon CHRISTANIS; Dr. Ali İhsan KARAYİĞİT; Dr. Hülya İNANER

C. Applied Geology & Geophysics

C.1 Air, Water and Soil Pollution
Conveners: Dr. Melis SOMAY; Dr. Celalettin ŞİMŞEK; Dr. Alper BABA

C.2 Engineering Geology
Conveners: Dr. Tamer TOPAL; Dr. Candan GÖKÇEOĞLU; Dr. Aykut AKGÜN

C.3 Engineering Geophysics: New Methods and Applications
Conveners: Dr. Meriç Aziz BERGE; Dr. Ferhat ÖZÇEP; Dr. Çağlayan BALKAYA

C.4 GIS and Remote Sensing applications
Conveners: Dr. Aykut AKGÜN; Dr. Bekir Taner SAN; Dr. Hakan Ahmet NEFESLIOĞLU
International Earth Science Colloquium on the Aegean Region
IESCA 2019

PROGRAM

October 7–11, 2019
Dokuz Eylül University, İzmir, TURKEY
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<th>Time</th>
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<th>Speaker</th>
<th>Title</th>
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<tbody>
<tr>
<td>09:00</td>
<td>15 Temmuz</td>
<td>Opening Speech</td>
<td>“Morphotectonic Development of Anatolia (Active tectonics and associated morphology)”</td>
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<tr>
<td>09:20</td>
<td>Bordo Hall</td>
<td>Dr. Yücel YILMAZ</td>
<td>A1-1 (p. 3): Late Palaeozoic-Cenozoic tectonic development of Anatolia: overview and alternatives</td>
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<tr>
<td>09:20</td>
<td>Mavi Hall</td>
<td>Dr. Aral OKAY</td>
<td>“The uplift of Anatolian Plateau - when and why did it occur?”</td>
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<tr>
<td>15:00</td>
<td>Bordo Hall</td>
<td>Dr. Maud J.M. MEIJERS</td>
<td>A1-5 (p. 7): Tectonic Analysis of the broader area of the Arakapas and Gerasa fault zones in SW Cyprus</td>
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<tr>
<td>15:00</td>
<td>Mavi Hall</td>
<td>A.1 Tectonics &amp; Paleogeography of Tethyan Oceans</td>
<td>A1-6 (p. 8): Priabonian – Rupelian obduction events in the Northeastern Aegean islands: correlation with the Thrace basin and the Rhodopes</td>
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<td>15:00</td>
<td>Bordo Hall</td>
<td>A.1 Tectonics &amp; Paleogeography of Tethyan Oceans</td>
<td>A1-7 (p. 9): Preliminary geochronological data of the cross-cutting dikes from the Devekelkë Metasalophite (Central Pontides, Turkey): Implications for the geodynamic evolution of a pre-Middle Jurassic oceanic crust fragment</td>
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<td>15:00</td>
<td>Mavi Hall</td>
<td>A.1 Tectonics &amp; Paleogeography of Tethyan Oceans</td>
<td>A1-8 (p. 10): Silicate exsolution micro-lamellae within the chromites of the SW Anatolian lithospheric mantle: More evidences for mantle recycling processes from the ancient Mediterranean lithospheric mantle?</td>
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<td>09:20</td>
<td>Mavi Hall</td>
<td>B3-2 (p. 154)</td>
<td>Thermalism in the Calabria Region (South Italy): hydrogeochemical, isotopic and geological characterization</td>
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<td>09:20</td>
<td>Bordo Hall</td>
<td>B3-3 (p. 155)</td>
<td>Use of primary geodetic data in identifying the active deformation in geothermal areas: the Aristino (NE Greece) case study</td>
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<td>09:20</td>
<td>Mavi Hall</td>
<td>B3-4 (p. 156)</td>
<td>Geothermal Mineral Recovery Possibilities in the High Temperature Geothermal Systems in Western Anatolia</td>
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<td>13:20</td>
<td>Bordo Hall</td>
<td>“Continental central Anatolian ecosystem and drainage evolution during Mio-Pliocene surface uplift”</td>
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<td>13:20</td>
<td>Mavi Hall</td>
<td>Dr. Maud J.M. MEIJERS</td>
<td>A1-5 (p. 7): Tectonic Analysis of the broader area of the Arakapas and Gerusa fault zones in SW Cyprus</td>
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<td>13:20</td>
<td>Bordo Hall</td>
<td>A.7 Paleomagnetic Investigations &amp; Reconstruction Studies</td>
<td>A7-3 (p. 107): Paleomagnetism of the Karlova Triple Junction and surrounding area, Eastern Anatolia</td>
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<td>17:20</td>
<td>A1-9</td>
<td>Cambrian-Early Ordovician magmatism, Mid-Late Palaeozoic sedimentation and Early Carboniferous metamorphism in the Central Sakarya Terrane, Sakarya Zone, NW Turkey</td>
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<td>18:10</td>
<td>A1-10</td>
<td>Geochronology and Hf isotope geochemistry of ophiolitic, felsic igneous and clastic sedimentary rocks exposed along a N-S transect from the Black Sea coast to the N Anatolian Fault in the Central Pontides, N Turkey</td>
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<td>A1-11</td>
<td>Mafic and ultramafic rocks within the Söğüt Metamorphics of the Sakarya Composite Terrane, NW Eskişehir, Turkey: Preliminary field and petrological findings</td>
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<td>A1-12</td>
<td>Tracing Triassic arc magmatism and related provenance variation along the Palaeotethyan active margin: Combined U-Pb and Lu-Hf isotopic evidence of detrital zircons in sandstones from the Tokat Massif (central Pontides) and the Ankara Mélange (central Anatolia)</td>
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<td>A1-13</td>
<td>Highlighting ductile deformations in the Chahna region (Small Kabylie -Algeria)</td>
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<td>A1-14</td>
<td>Tectonic analysis of South Setifian domain and its neighbors area (Eastern Algeria)</td>
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<td>B3-8</td>
<td>Water reservoir lifetimes from catchment-wide 10Be erosion rates – A case study from the central Menderes Massif (Western Turkey)</td>
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<td>B3-9</td>
<td>The use of Environmental isotopes to investigate recharge conditions of different aquifers in Tunisia</td>
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<td>B3-10</td>
<td>Classification and codification of karst aquifers in Aegean islands</td>
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<td>Time</td>
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<td>10:20</td>
<td>A3-1 (p. 45)</td>
<td>A5-1 (p.75)</td>
<td>C2-1 (p.201)</td>
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<tr>
<td></td>
<td>Origin of lime-rich San Venanzo Pleistocene volcanic rocks (central Italy). Source characteristics or effects of shallow carbonate interaction?</td>
<td>Mante Structure of Western Anatolia Obtained By Teleseismic Tomography</td>
<td>Major earthquakes (Mw ≥6.5) caused landslides occurred between 1998-2015 in the world</td>
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<td>A3-2 (p. 46)</td>
<td>A5-2 (p.76)</td>
<td>C2-2 (p.202)</td>
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<td>The pyroclastic breccia of Cabezo Negro de Talavera (SE Spain): first finding of carbonate magma in the Internal Domains of the Betics</td>
<td>On the Operation of an Earthquake Early Warning System at the Hellenic Subduction Zone</td>
<td>Use of waste glass as an additive material in stabilization of swelling clays</td>
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<td>A3-3 (p. 47)</td>
<td>A5-3 (p.77)</td>
<td>C2-3 (p.203)</td>
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<td>Age and geochemical constraints on petrogenesis of the Zajkan granite, Tarom-Hashtjin magmatic belt, NW Iran</td>
<td>Tectonic settings and neo-tectonics of the Aegean Sea as deduced from satellite altimeter</td>
<td>Estimation of the physical and mechanical properties of rocks</td>
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<td>11:20</td>
<td>A3-4 (p. 48)</td>
<td>A5-4 (p.78)</td>
<td>C2-4 (p.204)</td>
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<td>The Post-Collisional Sarıçehmet basalt: Whole rock K-Ar geochronology, geochemical, Sr–Nd isotopic and magma source characteristics, Eastern Anatolia, Turkey</td>
<td>Near-field Source Model for the 2017 Bodrum-Kos Earthquake (Mw=6.6): Triggered Off-fault Events to the Northeast of the Ruptured Fault Plane</td>
<td>The influence of anisotropy on Andisite rock strength in Borova district Izmir Turkey.</td>
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<tr>
<td>11:40</td>
<td>A3-5 (p. 49)</td>
<td>A5-5 (p.79)</td>
<td>C2-5 (p.205)</td>
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<td>In-situ crystallization of a small scale gabbroic body: the Yıldızdağı Gabbroic Intrusion (northern, Turkey)</td>
<td>Contribution in determination of the tectonic setting of Corinthus Gulf based on primary geodic data processing</td>
<td>The continuum and discontinuum modelling of a rock slope in Aydin, Turkey</td>
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<td>12:30</td>
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<tr>
<td>13:20</td>
<td>“Crustal Growth in the Western Anatolian Igneous Province”</td>
<td>Dr. Martin PALMER</td>
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<td>14:20</td>
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<tr>
<td>15:00</td>
<td>A3-6 (p. 50)</td>
<td>A5-6 (p.80)</td>
<td>C2-6 (p.206)</td>
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<td>Melting behavior of the xenolith bearing mafic rocks in Southern Thrace region: The significance of the peridotite to pyroxenite source transition</td>
<td>Decomposition of Site Terms from the Response Spectral Values: a case study for western Anatolia, Turkey</td>
<td>Assessment of waters of Euphrates – Tigris basin</td>
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<td>15:00</td>
<td>A3-7 (p. 51)</td>
<td>A5-7 (p.81)</td>
<td>C2-7 (p.207)</td>
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<td>Pristine vs. metamorphosed mantle source of Cenozoic Anatolian magmatism: insights from boron and radiogenic isotopes</td>
<td>The North Anatolian Shear Zone in the Western Marmara: Its fault structure, offset and age</td>
<td>Lessons from Eğirdere Landslide - 2019</td>
</tr>
<tr>
<td>15:20</td>
<td>A3-8 (p. 52)</td>
<td>A5-8 (p.82)</td>
<td>C2-8 (p.208)</td>
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<td>Miocene to Pliocene activity in Sivas-Malatya region, Central-Eastern Anatolia: time shift from subduction- to strike slip-related volcanism</td>
<td>Determination of hypocentral parameters of regional earthquakes with fuzzy logic</td>
<td>Effect of Disturbed Zone Depth on Slope Stability Analysis: a Case Study from Western Black Sea Region (Turkey)</td>
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<tr>
<td>15:40</td>
<td>A3-9 (p. 53)</td>
<td>A5-9 (p.83)</td>
<td>C2-9 (p.209)</td>
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<td>Debate on the presence of transitional rock association in post-collisional setting - examples from Carpathian – Pannonian Region and Anatolia</td>
<td>A stress release model in Egypt</td>
<td>Influence of physico-mechanical properties on the performance of blasting and its independence case MEFTEH quarry (Algeria)</td>
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<td>16:00</td>
<td>Coffee Break</td>
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8 October 2019 – TUESDAY (ORAL PRESENTATIONS)
<table>
<thead>
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<th>15 Temmuz Hall</th>
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<th>Mavi Hall</th>
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<tr>
<td>16:20</td>
<td>A3-10 (p. 54) Petrography, Mineral Chemistry and Geothermobarometry of the Gürgenyayla Pluton (NW Anatolia)</td>
<td>A8-1 (p. 111) Environmental isotopes and Noble gas signatures of Sfax deep groundwater (South-East of Tunisia) as Paleoclimate indicators</td>
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<tr>
<td>17:00</td>
<td>A3-12 (p. 56) Morphological characteristics, self-similar clustering and alignment analysis of Quaternary monogenetic vents in the Central Anatolian Volcanic Province</td>
<td>A8-3 (p. 113) The Largest (?) volcanic eruption from South Aegean Volcanic Province: It’s footprints in Western Anatolia</td>
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<td>17:20</td>
<td>A3-13 (p. 57) Morphological and depositional characteristics of Central Anatolian maar volcanoes: Field observations and ‘Structure from Motion’ photogrammetry</td>
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<td>17:40 – 18:30</td>
<td>A3-14 (p. 58)</td>
<td>40Ar/39Ar and U-Pb ages of the biggest Oligocene explosions in the Eastern Rhodopes, Bulgaria and their impact on the Eocene-Oligocene global climatic changes: Preliminary data</td>
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<td>17:40 – 18:30</td>
<td>A3-15 (p. 59)</td>
<td>Evaluating crust and mantle contributions in Early Oligocene Stomanovo ultra-K monzonite, Central Rhodopes, Bulgaria</td>
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<td>17:40 – 18:30</td>
<td>A3-16 (p. 60)</td>
<td>Petrology and geochemistry of the plutonite contact aureole in Kos Island, Greece</td>
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<tr>
<td>17:40 – 18:30</td>
<td>A3-17 (p. 61)</td>
<td>Mineral chemistry and termobarometric implications on Miocene volcanics in the northern part of Afyon Volcanics, Western Anatolia</td>
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<td>17:40 – 18:30</td>
<td>A3-18 (p. 62)</td>
<td>Sub-lithospheric mantle source of Na-alkaline and calc-alkaline magmas in the recent monogenetic volcanism of Cappadocia (Central Anatolia)</td>
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<td>17:40 – 18:30</td>
<td>A3-19 (p. 63)</td>
<td>Early Miocene to Pleistocene Na-alkaline Volcanism on the North-East Arabian plate (South-East Turkey)</td>
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<tr>
<td>17:40 – 18:30</td>
<td>A3-20 (p. 64)</td>
<td>Geochemical-petrological characteristics and U-Pb zircon geochronology reveal the emplacement history of the Turgutreis-Bodrum Monzonite, southwestern Anatolia, Turkey</td>
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<td>17:40 – 18:30</td>
<td>A5-10 (p.84)</td>
<td>Underlying Causes of the Extensional Deformation in Western Anatolia</td>
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<td>17:40 – 18:30</td>
<td>A5-11 (p.85)</td>
<td>Strong-Motion Seismic Monitoring for Engineering Applications in SW Turkey</td>
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<td>17:40 – 18:30</td>
<td>A5-12 (p.86)</td>
<td>A case of active fault migration in Mygdonia basin, northern Greece</td>
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<td>17:40 – 18:30</td>
<td>A5-13 (p.87)</td>
<td>The 141/142 A.D. Lycian earthquake: where and how?</td>
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<tr>
<td>18:30 – 19:20</td>
<td>C2-10 (p. 210)</td>
<td>Analysis of pillar design practices using different approaches (Case of the mine of Setif -Algeria)</td>
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<tr>
<td>18:30 – 19:20</td>
<td>C2-11 (p. 211)</td>
<td>Hydro-geochemical characterization of a multilayer aquifer, in Northeastern Algeria</td>
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<td>18:30 – 19:20</td>
<td>C2-12 (p. 212)</td>
<td>Identification and Mapping of Land Movement on the National Road 09 Setif-Baja North East Algeria</td>
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<tr>
<td>18:30 – 19:20</td>
<td>C2-13 (p. 213)</td>
<td>Rock slope stability problems in the area of Kaliakra Cape, NE Bulgaria</td>
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### 9 October 2019 – WEDNESDAY (ORAL PRESENTATIONS)

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<tr>
<th>Time</th>
<th>“Aegean and Eastern Mediterranean hydrocarbons, legal status and geopolitical appearance”</th>
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<tr>
<td>10:20</td>
<td>( B_5) - (p.177) Tectonic Structure of the Eastern Mediterranean Area as the Upcoming Hydrocarbon Province of the World</td>
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<tr>
<td>10:40</td>
<td>( C_4) - (p.229) GIS-based model to assess soil erosion using RUSLE in the Mellegue watershed, Algeria</td>
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<tr>
<td>11:00</td>
<td>( A_9) - (p.117) Application of Cathodoluminescence Microscopy for the characterization of some Roman-Late Roman wares from surface survey in Sphakia area, Crete, Greece</td>
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<td>11:20</td>
<td>( B_5) - (p.178) First insights into peat-forming environments in Mozambican side of Maputaland, Mozambique</td>
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<td>11:40</td>
<td>( C_4) - (p.230) Spot images remote sensing study of the fractured tabular Middle Atlas aquifer (Morocco)</td>
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<tr>
<td>12:00</td>
<td>( A_9) - (p.118) New Geosite Candidates from Urla (İzmir, Western Anatolia, Turkey): A list of Geological Assets Nested with the Antique and Modern Cultural Heritage</td>
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<tr>
<td>12:20</td>
<td>( B_5) - (p.180) Maturation trends within the Oligocene Pindos Foreland in Western Greece</td>
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<tr>
<td>12:40</td>
<td>( C_4) - (p.232) Delineation of Lead - Zinc Deposits in Eastern Tauroides Using Remote Sensing Techniques (Havadan – Kayseri)</td>
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<td>12:40</td>
<td>( A_9) - (p.120) Travertine Spring Towers as Rare Depositional Morphologies in Geothermal Fields: An Example from the Hisaralan Geothermal Area (Sindрог, Balıkesir, NW Turkey)</td>
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<tr>
<td>13:00</td>
<td>( B_5) - (p.181) The Turkish Cenozoic Coals: A review of coal petrology, mineralogy and geochemistry</td>
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<td>13:20</td>
<td>( C_4) - (p.233) Determination of Contact between Different Carbonate Rocks with Remote Sensing Methods (N Adıyaman – Turkey)</td>
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<td>13:20</td>
<td>( A_8) - (p.121) Sarcothaphus of Assos: Geoaacrchaeological Perspectives</td>
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**SOCIAL ACTIVITIES**

visit to Ephesus
### 10 October 2019 – THURSDAY (ORAL PRESENTATIONS)

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<td>09:00-10:00</td>
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<td>“An Overview of 25 Years in the Menderes Massif, Western Turkey”</td>
<td>Dr. Erdin BOZKURT</td>
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<td>A4-1 (p. 67) Late Oligocene – Early Miocene deformation in the Thrace</td>
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<td>Basin and the structure of the Kuru Dağı, NW Turkey</td>
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<td>A4-2 (p. 68) Micro-tectonics of the Northern Kapıdağ Pluton (NW Turkey)</td>
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<td>A4-3 (p. 69) Kinematics of Burka Fault and its Relation to</td>
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<td>Southern Branch of North Anatolian Fault Zone</td>
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<td>A4-4 (p. 70) Post Miocene structural elements controlling</td>
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<td>A4-5 (p. 71) Porphritic Domes and Normal Fault in Strike -</td>
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<td>Slip Environment Examples From Tunceli and its Surroundings</td>
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<td>13:20-14:20</td>
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<td>“Engineering Seismology Case Studies”</td>
<td>Dr. Özdoğan YILMAZ</td>
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<td>14:40-15:00</td>
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<td>C3-1 (p. 217) A contribution of ASTER and airborne</td>
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<td>geophysical data for evaluating mineralization potential in</td>
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<td>Dungansh-Atud area, southeastern Desert, Egypt</td>
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<td>C3-2 (p. 218) Global Optimization of Total Field Magnetic</td>
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<td>Anomalies Due to Fault Structures: Differential Evolution</td>
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<td>versus Particle Swarm Optimization</td>
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<td>C3-3 (p. 219) Global Optimization of Basement Relief Through</td>
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<td>Differential Evolution: A Case from the Aegean Graben System,</td>
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<td>C3-4 (p. 220) New Insight from the North Anatolian Fault from</td>
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<td>multi-channel seismic reflection imagery in Adapazarı Basin, Eastern</td>
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<td>C3-6 (p. 222) Crosshole resistivity and seismic imaging: results of</td>
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### 10 October 2019 – THURSDAY (ORAL PRESENTATIONS) continued

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**17:00 – 17:20**

- Effects of operation mode on the efficiency of upflow anaerobic filter treating baker’s yeast industry’s waste water (C1-7)
- Alteration of the waters of Wadi Meboudja (Annaba) by the solid rejections of the metal industry (C1-8)

**17:20 – 17:40**

- Effects of operation mode on the efficiency of upflow anaerobic filter treating baker’s yeast industry’s waste water (C1-7)
- Alteration of the waters of Wadi Meboudja (Annaba) by the solid rejections of the metal industry (C1-8)

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### 10 October 2019 – THURSDAY (POSTER PRESENTATIONS)

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<th>A2-15 (p. 29)</th>
<th>A2-16 (p. 30)</th>
<th>A2-17 (p. 31)</th>
<th>A2-18 (p. 32)</th>
<th>B4-5 (p. 171)</th>
<th>B4-6 (p. 172)</th>
<th>B4-7 (p. 173)</th>
<th>C1-9 (p. 195)</th>
<th>C1-10 (p. 196)</th>
<th>C1-11 (p. 197)</th>
<th>C1-12 (p. 198)</th>
<th>C3-7 (p. 223)</th>
<th>C3-8 (p. 224)</th>
<th>C3-9 (p. 225)</th>
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<td>17:20</td>
<td>Lithostratigraphical and sedimentological characterization of the Aptian formation on the Northern flank of Dj Bou Arif (NE of Algeria)</td>
<td>The Campanian-Maastrichtian series of Dj. Gaša (Tebessa, NE of Algeria): quantitative and qualitative analysis and palaeoenvironmental interpretation</td>
<td>Facies Analysis, Sedimentary Environments and Diagenetic Processes of Surmeh Formation at the Balal and Salman Field, Persian Gulf</td>
<td>Stratigraphy and tectonics of Kastas Hill and broader area, Strymon basin, Northern Greece</td>
<td>Rocktomic Properties of Natural Stones Used in Aphrodisias Ancient City, Relationship with Environmental Geology and a New Classification Approach</td>
<td>Determination of the Local Granitic Potential of the Granitic Rock of the Eastern Region of Algeria by Geotechnical Methods</td>
<td>Study and analysis of the cement quality obtained from a mixture of two baked and unbaked clinkers of Hdjar Soud cement factory, Skikda, Algeria</td>
<td>Characterization of ironworks waste, for their industrial application; case of el-hadjar slag, eastern of Algeria</td>
<td>Distribution and mobility of arsenic and heavy metals in the soils close to the mining site of Grammatiko, North Attica (Greece)</td>
<td>Hydrogeochemical Interpretation of Milas (Muğla) Salty Karstic Springs</td>
<td>Investigation of child parks in Izmir using magnetic susceptibility and radiometric methods</td>
<td>Interpretation of Magnetic Data Using Radial Amplitude Spectrum Analysis: A Case from Gölcük/Isparta Region</td>
<td>A Benchmark study: numerical fluid flow and temperature modeling of Basin and Range geothermal system</td>
<td>Temperature and fluid flow modeling of gas bearing sediments in Offshore Antarctic Peninsula South Shetland Islands</td>
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<td><strong>Overview of the origin and distribution of primary economic source of borate deposits</strong></td>
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<td>B2-1 (p. 143) The evidences of some stable isotope compositions of the Miocene halites related</td>
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<td>B2-3 (p. 145) Geological, Mineralogical and Geochemical Occurrence Of Bentonite Deposits in</td>
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<td>the Bigadiç Borate Basin, Balikesir, Western Turkey</td>
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<td>B2-4 (p. 146) Distribution of Alteration Minerals in Volcanic Rocks in Central Sakarya Zone</td>
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<td>Examination of Eocene Bayburt Amber</td>
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<td>B2-7 (p. 149) Hydromagnesite formation and its significance in the Çameli Basin, Southwestern</td>
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<td>B1-4 (p. 130) Preliminary results of Au-Sb mineralization related to extensional tectonics in the</td>
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XX
### 11 October 2019 – FRIDAY - (POSTER PRESENTATIONS)

| A2-19 (p. 37) | Maastrichtian drowning of a carbonate platform within the Bornova Flysch Zone (Spil Mountain, Manisa, western Turkey): Preliminary data based on dasyclad algae and planktonic foraminifera |
| A2-20 (p. 38) | New foraminiferal ages from Mesozoic carbonate blocks between Menderes and Gümüldür (İzmir, western Anatolia): comparison with nearby carbonate sequences |
| A2-21 (p. 39) | Late Cenomanian-?late Turonian planktonic foraminiferal biostratigraphy of a pelagic Tavas Nappe succession from the Kizica area (Tavas, Denizli) of the Lycian nappes (SW Turkey): Preliminary results |
| A2-22 (p. 40) | Palaeoenvironmental evolution of the Eocene Marine Evaporite bearing units in the Western Pontides (Karabük area of NW Turkey): Palynoflora, Foraminifers, Nannoplanktons and Clay mineralogy |
| A2-23 (p. 41) | Primary palynological and palaeovegetational data of the Middle-Late Eocene sediments of the Yozgat province in the Central Anatolia |
| A5-10 (p.100) | Automated seismic interpretation using edge detection techniques |
| A5-11 (p.101) | Temporal gravity variations and its relation to seismic activities in some active areas in Egypt |
| B1-8 (p. 134) | Characterization of the potential in some trace elements of the Edough Massif (North East of Algeria) |
| B1-10 (p.136) | Mineralogy and geochemistry of the Fe-Mn crusts and nodules in piemontite-schists of the Cycladic Blueschist Unit rocks of Varnavas area, NE Attica, Greece |
| B1-11 (p.137) | Mineralogy, geochemistry and C, O isotope study of the iron-oxide deposit at Grammatiko, NE Attica, Greece: ore genesis in an extensional setting |
| B1-12 (p. 138) | Geology, geochemistry and isootope characteristics of Danderesi (Baikeşir,Turkey) Pb-Zn (Au-Ag) mineralization |
| B1-13 (p. 139) | Comparative investigation of Esendemirtape skarn and Horoz skarn mineralizations in Ulukışla (Nigde) Basin |
| B1-14 (p. 140) | The Relationship between physico-chemical properties of solutions and structural control on Efemçukuru hydrothermal mineralisation |
| B2-7 (p. 149) | Clay mineralogy and geochemistry of Turgut coal bearing sediments (Muğla-Turkey) |

### 12 – 13 October 2019 – 2-days post colloquium field trip

Day 1: Neoproterozoic to Palaeozoic stratigraphy and Early Cambrian high-pressure metamorphic records in the Menderes Massif

Day 2: The low-angle detachment fault, responsible for the Miocene exhumation of the Menderes Massif, the Miocene supra-detachment sedimentary units, the Gediz graben and the Quaternary basaltic volcanism of Kula
ABSTRACTS
### ABSTRACTS

**A. Regional Geology of the Aegean and the Environs**

**A.1 Tectonics & Paleogeography of Tethyan Oceans**

**Conveners:** Dr. Alastair ROBERTSON; Dr. Osman PARLAK; Dr. Timur USTAÖMER

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<th>Paper Title</th>
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<td>A1-1 Late Palaeozoic-Cenozoic tectonic development of Anatolia: overview and alternatives</td>
<td>Alastair Robertson, Osman Parlak, Timur Ustaömer</td>
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<td>A1-2 From arc evolution to arc-continent collision: Late Cretaceous–middle Eocene geology of the Eastern Pontides, northeastern Turkey</td>
<td>Özgür Kandemir, Kenan Akbayram, Mehmet Çobankaya, Fatih Kanar, Şükri Pehlivan, Turgut Tok, Aynur Hakyemez, Erkan Ekmecki, Fıssun Danaci, Uğur Temiz</td>
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<td>A1-3 Rifting/passive margin development of the Southern Neotethys: evidence from the Antalya Complex in the Alanya Window (Gazipaşa-Anamur area)</td>
<td>Alastair Robertson, Osman Parlak, Tim Kinnaird, Komal Tasi, Paulian Dumitrica</td>
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<td>A1-4 Comparison and Correlation of two Triassic bauxite-bearing carbonate and meta-carbonate sequences from Bornova Flysch Zone (Urla-İzmir) and Cycladic Unit (Söke-Aydın) in western Anatolia</td>
<td>İsmail İşințek</td>
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<td>A1-5 Tectonic Analysis of the broader area of the Arakapas and Gerasas fault zones in SW Cyprus</td>
<td>Antriani Varnava, Adamantios Kilias, Alexandros Chatzipetros, Spyros Pavlidès</td>
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<td>A1-6 Priabonian – Rupelian olistostromal events in the Northeastern Aegean islands: correlation with the Thrace basin and the Rhodopes</td>
<td>İvan Zagorchev, Kristalina Stoykova, Daria Ivanova, Davide Bassi</td>
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Tectonics & Paleogeography of Tethyan Oceans

Conveners:
Dr. Alastair ROBERTSON; Dr. Osman PARLAK;
Dr. Timur USTAÖMER
Late Palaeozoic-Cenozoic tectonic development of Anatolia: overview and alternatives

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Based on input from Turkish and international geoscientists, recently published Permian to Neogene palaeogeographic maps of the DARIUS program illustrate many widely accepted interpretations. Subduction of both Palaeotethys and Neotethys was essentially northwards beneath Eurasia during Late Palaeozoic-Paleogene time. Neotethys opened by rifting of continental fragments from Gondwana during northward subduction, creating, from N to S: the Intra-Pontide ocean, Izmir-Ankara-Erzincan ocean, Inner Tauride ocean (in the E), Berit ocean (also in the E) and the Southern Neotethys. The Central Anatolian Crystalline Complex (Kırşehir massif) rifted from the Tauride-Anatolide crustal block during the opening of the Inner Tauride ocean. Supra-subduction zone spreading took place to form future ophiolites, during the Early-Mid Jurassic (c. 177-167 Ma) within the Izmir-Ankara-Erzincan ocean, and also during the Late Cretaceous (c. 92-90 Ma), apparently within the Inner Tauride ocean, Berit ocean and Southern Neotethys. The Inner Tauride ocean and the Berit ocean sutured during the Late Cretaceous and/or Paleogene, the Izmir-Ankara-Erzincan ocean prior to the late Mid-Eocene (Bartonian) and the S Neotethys prior to the mid-Miocene (Langhian). The Eastern Mediterranean Sea is a relic Mesozoic ocean that is undergoing diachronous continental collision, exemplified by Plio-Quaternary northward underthrusting of the Eratosthenes Seamount (continental crust) along a subduction zone to the S of Cyprus.

Various alternative interpretations, however, need to be considered based on recent literature. These include 1. Whether Palaeotethys (for some, Rheic ocean) sutured in the Aegean to central/western Europe region by late Carboniferous or instead remained open until the latest Triassic; 2. The possible role of (additional?) southward subduction beneath Gondwana during Carboniferous and/or Triassic; 3. Possible latest Triassic (‘Cimmerian’) collision between the Tauride and Tavşanlı/Afyon crustal units; 4. Whether the Afyon and Tavşanlı units should be correlated with the Tauride crustal unit or with Eurasia (Sakarya zone); 5. Whether the Menderes Massif, and also the Afyon and Tavşanlı crustal units, formed part of a large Tauride-Anatolide crustal block, or several microcontinents surrounded by Mesozoic oceanic crust. 6. Could the late Cretaceous ophiolites in multiple suture zones have originated by rollback from a single supra-subduction zone oceanic slab located to the east? 7. Did sub-ophiolite soles form contemporaneously with supra-subduction zone spreading to form (future) ophiolites, or represent accreted/exhumed older oceanic lithosphere? 8. Is more than one subduction zone preserved along (one or more) suture zones (continental margin and mid-ocean)? 9. Alternative timings of collision; e.g. Neogene for the Izmir-Ankara-Erzincan ocean; Late Cretaceous or Eocene for the Inner Tauride ocean, Berit ocean and S Neotethys; 10. A recent hypothesis that the ‘southern ocean’ comprises two different basins, of which one in the N (S Neotethys) rifted during Permian-Triassic, whereas the other, farther south, formed independently during the Cretaceous as a Mediterranean-scale pull-apart basin, bounded by c. E-W transforms that were located along the N African continental margin and in S Greece/Anatolia (now subducted).

Utilising recently available information, such tectonic alternatives will be discussed, leading to updating of existing palaeographic maps where appropriate.

Keywords: Anatolia; tectonic development; palaeogeography; Tethys; alternative hypotheses
From arc evolution to arc-continent collision: Late Cretaceous–middle Eocene geology of the Eastern Pontides, northeastern Turkey

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The Eastern Pontide Arc, a major fossil submarine arc of the world, was formed by northward subduction of the northern Neo-Tethys lithosphere under the Eurasian margin. The arc’s volcano-sedimentary sequence and its cover contain abundant fossils. Our new systematical palaeontological and structural data suggest the Late Cretaceous arc volcanism was initiated at early-middle Turonian and continued uninterruptedly until the end of the early Maastrichtian, in the northern part of the Eastern Pontides. We measured ~5500-m-thick arc deposits, suggesting a deposition rate of ~220 m Ma⁻¹ in ~25 m.y. We have also defined four different chemical volcanic episodes: (1) an early-middle Turonian–Santonian mafic-intermediate episode, (2) a Santonian acidic episode; when the main volcanic centers were formed as huge acidic domes-calderas comprising the volcanogenic massive sulfide ores, (3) a late Santonian–late Campanian mafic-intermediate episode, and (4) a late Campanian–early Maastrichtian acidic episode. The volcaniclastic rocks were deposited in a deepwater extensional basin until the late Campanian. Between late Campanian and early Maastrichtian, intra-arc extension resulted in opening of back-arc in the north, while the southern part of the arc remained active and uplifted. The back-arc basin was most probably connected to the Eastern Black Sea Basin. In the back-arc basin, early Maastrichtian volcano-sedimentary arc sequence was transitionally overlain by pelagic sediments until late Danian suggesting continuous deep-marine conditions. However, the subsidence of the uplifted-arc-region did not occur until late Maastrichtian. We have documented a Selandian–early Thanetian (57–60 Ma) regional hiatus defining the closure age of the İzmir-Ankara-Erzincan Ocean along the Eastern Pontides. Between late Thanetian and late Lutetian synorogenic turbidites and postcollisional volcanics were deposited. The Eastern Pontide fold-and-thrust belt started to form at early Eocene (ca. 55 Ma) and thrusting continued in the post-Lutetian times.

Keywords: Black Sea; collision; Eastern Pontides; Neo-Tethys; submarine volcanic arc
Rifting/passive margin development of the Southern Neotethys: evidence from the Antalya Complex in the Alanya Window (Gazipaşa-Anamur area)

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A large but little-studied outcrop of the Antalya Complex (Antalya nappes) occurs within a regional-scale window through the metamorphic Alanya Massif. Aided by new sedimentological, biostratigraphical and micropaleontological (calcareous and siliceous micr ofossils) information the following geological development is proposed: Late Cambrian-Early Ordovician clastic sediments accumulated along the N margin of Gondwana on a storm-affected, shallow-marine shelf, influenced by the eustatic sea-level change. Above an angular unconformity, probably related to rift-shoulder uplift (first main rift phase), Late Permian facies document a range of shallow-marine to evaporitic environments during regional tectonic subsidence. Above a second unconformity, Early Triassic carbonates and mudrocks accumulated on an unstable, gently subsiding shelf. Mudrocks, sandstones and lithoclastic debris-flows (derived from underlying units) accumulated during Mid-Triassic (Anisian-early Ladinian) implying marked tectonic subsidence (second main rift phase). Radiolarian mudstones were laid down during late Middle Triassic-early Late Triassic (late Ladinian-early Carnian) in a well-oxidised, organically productive, relatively quiescent, deep-water setting. Thick (100s m) siliciclastic sandstone turbidites (commonly plant-rich), together with localised debris-flows, accumulated during the Late Triassic (later Carnian) (third and final major rift phase). Final continental break-up then created the S Neotethys, based mainly on evidence from the Güzelsu area (to the N and NW) and the Antalya-Kumluca area (to the SW). The succession in the Antalya Window continues with mudrocks containing meter-sized blocks of Late Triassic (Norian) reef limestone; these resulted from carbonate platform upgrowth and marginal collapse. Radiolarites accumulated during Jurassic-Cretaceous below the CCD, interbedded with re-deposited platform carbonates (commonly silicified calciturbidites), representing a prolonged period of passive margin subsidence. A platform-margin setting (probably channelised) is indicated by the local presence of Jurassic-Cretaceous redeposited neritic carbonate (mass-flow deposits), overlaying hemipelagic limestone (with nodular chert) and finally by latest Cretaceous pelagic limestone. In the centre-east of the outcrop, Jurassic-Cretaceous shallow-water limestones (100s m-thick) can be correlated with similar carbonate units elsewhere in the Antalya Complex (upper Antalya nappe). Igneous rocks in the Alanya Window are essentially restricted to rare sill-like intrusions of alkaline dolerite cutting the Triassic succession. Structural data, utilising outcrop-scale ductile, semi-ductile and penetrative structures, suggest compressional deformation along an N-S to NE-SW principal axis; however, folds with E-W, N-S, S-N or variable vergence are also present. Satellite imagery further suggests the presence of semi-ductile folds (up to km-scale), with variable vergence, especially in the south. Some areas (in the NW) include concentrations of detached blocks (up to 100s m-sized) of mainly Late Permian-Triassic lithologies within Late Triassic turbidites. The block margins are sheared, faulted and brecciated suggesting a structural origin, probably related to tectonic emplacement. A tectonic origin is also likely for previously reported olistostomes above Late Cretaceous pelagic carbonates (in the NW). The sediments in the Alanya Window, therefore, document pulsed Permian-Triassic rifting and late-Mesozoic passive margin subsidence in a proximal setting adjacent to a Mesozoic carbonate platform. The sediments were initially deformed and metamorphosed to low-grade (increasing southwards) probably during the latest Cretaceous, followed by final northward overthrusting by the Alanya Massif metamorphic rocks (previously exhumed) during the Eocene.

Keywords: S Turkey; Antalya Complex; Alanya window; rifting; S Neotethys
Comparison and Correlation of two Triassic bauxite-bearing carbonate and meta-carbonate sequences from Bornova Flysch Zone (Urla-İzmir) and Cycladic Unit (Söke-Aydın) in western Anatolia

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In the Özbek Peninsula (Urla-İzmir), a thick Triassic carbonate sequence is exposed within the Bornova Flysch Zone of the Tauride-Anatolide Block. In the northwest of the Özbek Village, the carbonate succession is divided into two parts by a bauxite horizon: The Middle to Late Triassic lower limestone unit and the Norian-Rhaetian upper limestone unit. The upper limestone unit is strongly dolomitic in character.

The pelagic to lagoonal limestones of lower limestone unit includes *Arenovidalina* sp., *Endotriadella* wirzi, *Reophax* sp., *Trochammina* sp., *Auloconus* sp., *Aulotortus* cf. *sinuosus*, *Aulotortus* sp. foraminifers indicating a Middle to Late Triassic age. The upper limestone is characterized by intertidal and subtidal to lagoonal dolomitic limestones containing *Endotriadella* sp., *Textularia* sp., *Trochammina* sp., *Glomospira* sp., *Glomospirella* sp., *Aulotortus gaschei*, *A. friedli*, *A. communis*, *A. gr. sinuosus*, *A. tenuis*, *A. impressus*, *A. tumidus*, *Aulotortus* sp. and *Auloconus permodisoides* foraminifers. This foraminiferal association reflects a Norian-Rhaetian age for the upper limestone unit. The foraminifer assemblage, determined in the beds below and above the bauxite zone allows us to assign a Late Triassic age for the bauxite horizon. This sequence is the unique non-metamorphic Late Triassic bauxite-bearing sequence, known in western Anatolia.

On the other hand, in the previous studies, a Triassic meta-bauxite-bearing meta-carbonate sequence has been documented within the metamorphic Cycladic Unit in the north of Söke (Aydın). In this area, the metamorphic sequence is represented by mica schists in the lower part and a thick Triassic to Cretaceous meta-carbonate succession in the upper part. The meta-bauxite level is found in the lower part of the meta-carbonates, between dolomitic marbles below and meta-dolomites above. Existence and stratigraphic setting of the Triassic bauxite levels, as well as stratigraphic and lithologic similarities of bauxite-bearing beds within non-metamorphic and metamorphic carbonate sequences, suggest that these two sequences are comparable and Özbek Peninsula carbonate sequence can be interpreted as non-metamorphic equivalent of the Cycladic Unit settled in the Bornova Flysch Zone.

**Keywords:** bauxite upper Triassic; Cycladic unit; carbonates; foraminifer
Tectonic Analysis of the broader area of the Arakapas and Gerasas fault zones in SW Cyprus

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The objective of this research is to study the structure of mainly the Arakapas fault zone, as well as the Gerasas one, both of them located at the southwestern part of Cyprus Island. Arakapas fault zone was first developed during the same period with the Troodos ophiolite, in Upper Cretaceous, therefore it is characterized as a “fossil” transform fault. During Miocene-Pliocene, both zones were operating simultaneously as two strike-slip faults, causing thus the lateral escape of Limassol Forest area.

Keywords: Arakapas fault zone; Gerasa fault zone; Troodos ophiolite
Priabonian – Rupelian olistostromal events in the Northeastern Aegean islands: correlation with the Thrace basin and the Rhodopes

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We report a major olistostromal event situated around the Priabonian/Rupelian boundary. It is manifested in the island of Samothraki simultaneously with the development of a carbonate reef, preceded and followed by flyschoid sedimentation. Olistostrome formation of the approximately the same age is observed also in the SE part of the island of Lemnos. Comparisons with the Thracian basin and the Rhodopes hint at the links of olistostrome and mélange formation with an episode of carbonatic sedimentation brusquely disturbed by increased tectonic activity of regional importance.

Keywords: olistostromal event; Thracic basin; Eocene-Oligocene
Preliminary geochemical data of the cross-cutting dykes from the Devrekani Metaophiolite (Central Pontides, Turkey): Implications for the geodynamic evolution a pre-Middle Jurassic oceanic crust fragment

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The Central Pontides (northern Turkey), one of the most complicated regions of Turkey, comprises of the pre-Jurassic basement units, the Early Jurassic and the Early Cretaceous accretionary complexes, the widespread Middle Jurassic continental arc magmatic and the Late Jurassic to Tertiary cover units. There are several Middle Jurassic oceanic units, which were metamorphosed in the Early Cretaceous and represent an accretionary prism known as the Central Pontide Supercomplex or Central Pontide Structural Complex. In addition to these oceanic units, recently, a few pre-Middle Jurassic metaophiolite and serpentinite fragments have been recognized within the basement units, which may be remnants of an older ocean. For instance, the Devrekani Metaophiolite is tectonically intercalated within the Devrekani Metamorphics and sandwiched between the Devrekani Metamorphics and the Çangaldağ Metamorphic Complex. It is mainly composed of serpentinites; harzburgites, dunites and metagabbros, and cut by metabasaltic andesites and metadacites. The meta-dacite displays aphanitic/microphaneritic and porphyritic texture, and the phenocrysts are represented by plagioclase, quartz and mica crystals. The primary constituents of metabasaltic andesite are plagioclase and mica crystals, and it displays aphanitic/microphaneritic and porphyritic texture. Here, the oriented subhedral to euhedral mica flakes represent the common phase in the metabasaltic andesite. The gabbro is composed mainly of plagioclase and pyroxene crystals, and exhibit phaneritic/porphyritic texture. The plagioclase crystals are partly altered to sericite minerals, and occur as anhedral and subhedral crystals. Based on the immobile trace element systematics of all magmatic rocks, two different groups belonging to completely different tectono-magmatic settings including continental arc and fore-arc supra-subduction (boninitic), have been geochemically determined. The metadacite and metabasaltic andesite samples are akin to Cordilleran-type volcanic arc, and characterized by negative Nb and Ta anomalies and depleted HFSEs relative to Th and La contents. In addition, the volcanic arc characteristic of these rocks is supported by LREE enrichments over HREE reflecting contribution from a subduction-related component. In contrast, the gabbro samples display the geochemical signatures of boninitic rocks and characterized by strong depletion in HFSEs and REEs relative to N-MORB. In conclusion, the Devrekani Metaophiolite may represent another remnant of a pre-Middle Jurassic oceanic crust generation in the Tethyan Belt. Subsequent to its imbrication within the Variscan basement (Devrekani Metamorphics), it could have been cut by small-volume intrusions of the Middle Jurassic continental arc magmatism.

Keywords: Immobile trace elements; continental arc; boninitic magmatism; pre-Middle Jurassic oceanic crust; Central Pontides
Silicate exsolution micro-lamellae within the chromites of the SW Anatolian chromitites: More evidences for mantle recycling processes from the ancient Mediterranean lithospheric mantle?

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Recent researches on the ophiolitic chromitites have revealed peculiar findings alleging evidences of recycling of the crustal and mantle material in the lithospheric mantle. These are generally manifested in the form of micro-scale evidences in the chromitites such as the existence of accessory/exotic phases of crustal (e.g., zircons) and super reducing/ultrahigh pressure (SuR/UHP - e.g., moissanite, micro-diamonds, crystallographically oriented silicate micro-lamellae, etc) origins. Previous researches on such accessory/exotic minerals from the chromitites located within the ophiolite belts of Turkey (e.g., zircons from the Lycian-Antalya chromitites, both zircons and SuR-UHP phases from the Pozanti-Karsanti chromitites, and selectively oriented diopside exsolution micro-lamellae/needles from the Orhaneli chromitites) suggest a (partially deep) mantle recycling history for the ancient Mediterranean lithospheric mantle.

This current study reports new findings from the chromitites of the Lycian Peridotite Nappes in southwestern Turkey. Microscopic studies have revealed that the chromite grains of the chromitites from three mining districts in the Lycian Peridotite Nappes (Harmancık, Domuzalan-Yürek-Çenger and Elmaslar) include micro-needles/lamellae (<50 microns in length and <1 microns in thickness) that are hard to be effectively determined with only using a reflected-light microscope. Up to six different sets of intersecting selectively oriented micro-needles/lamellae are observed in a single chromite grain. The reflected-light microscope findings are further assisted by micro-Raman and Scanning Electron Microscopy-Energy Dispersive Spectroscopy (SEM-EDS) techniques. The Raman spectral peaks obtained from these needles/lamellae are usually hard to subtract from that of the surrounding chromites’ due to their extremely fine dimensions (usually nanometric thicknesses) and give a composite spectra generally concealing the peaks from the needles/lamellae. However, a larger and thicker occurrence shows certain peaks (at ca. 325 and 1014 cm⁻¹) that are in good agreement with two of the stretching modes of diopside from the literature. Further X-Ray mapping of the micro-lamellae/needle clusters also show that these needles/lamellae are characterized by significant presence of Ca and Si and absence of Cr and Fe. Most of the obtained EDS spectra also presents significant presence of Ca, Si, Mg and O with notable addition of Cr, Fe and Al, probably from the chromite host. These observations suggest that these selectively oriented clusters of micro-lamellae/needles within the chromite grains are mainly diopside. One single micro-lamellae is determined as enstatite due to its Ca-lacking elemental spectra. These diopside and enstatite micro-lamellae/needles are chemically and morphologically similar to the previously described diopside exsolution micro-lamellae from the Orhaneli chromitites which were suggested to be indicators of deep mantle recycling events. Hence current findings may also be discussed as an initial point for questioning a mantle recycling history for at least some of the chromitites of the Lycian Nappes.

Keywords: Ophiolitic chromitites; silicate exsolution micro-lamellae; deep mantle recycling; Mediterranean lithospheric mantle
Cambrian-Early Ordovician magmatism; Mid-Late Paleozoic sedimentation and Early Carboniferous metamorphism in the Central Sakarya Terrane; Sakarya Zone; NW Turkey

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The main objective here is to understand better the multi-stage tectonic development of the Central Sakarya terrane (Sakarya Zone); which is dominated by previously undated metamorphic rocks and cross-cutting Late Carboniferous granitoid intrusions. 1/25.000-scale mapping of an area between İnhisar and Sarıçakaya has revealed a south-vergent thrust stack made up of three slices. High-grade metamorphic rocks; forming the middle slice; are sandwiched between two lower-grade metamorphic slices. We focus here on the middle slice which exhibits a basement and cover-type stratigraphy. The basement is made up of meta-granites (felsic orthogneiss) and cross-cutting meta-gabbros (mafic orthogneiss); and is disconformably overlain by a meta-clastic cover succession consisting of meta-conglomerates; quartzites; quartz-schists and paragneiss.

The basement meta-granites are composed of quartz; K-Feldspar; plagioclase; biotite; muscovite and garnet. The meta-gabbros have a modal composition of plagioclase; amphibole; biotite and sphene. In tectonic discrimination diagrams; the meta-granites plot mainly in the Volcanic Arc Granite field; with some in the Within-Plate Granite field. The meta-gabbros are alkaline and mainly plot in the Within-Plate field.

U-Pb dating was carried out on extracted zircon crystals using LA-ICP-MS at Goethe University-Frankfurt; Germany. Also; Ar-Ar dating of micas was carried out at the University of Nevada; USA. Five different meta-granite bodies yielded concordia ages of 503±12 Ma; 500±11 Ma; 488.8±5.1 Ma; 473.9±5.7 Ma and 473±5.5 Ma (Cambrian-Early Ordovician). A sample of meta-gabbro gave an age of 472.2±5.9 Ma (Early Ordovician). These ages are interpreted as the crystallization ages of the igneous protoliths. Detrital zircons from a meta-conglomerate sample that is rich in granite and quartz clasts yielded a prominent population of Cambro-Ordovician age (532 to 444 Ma); with smaller populations of Ediacaran (~570 Ma); Tonian-Stenian (0.8-1.1 Ga) and Paleoproterozoic (2.5 Ga) ages. The youngest zircon age in the sample (444±3 Ma) constrains the maximum depositional age of the lower part of the meta-sedimentary cover to around the Ordovician-Silurian boundary. The cross-cutting Sarıçakaya granitoid gave a concordia age of 318±3 Ma (Late Carboniferous). We also dated biotites and muscovites from a paragneiss sample of the cover to help constrain the age of metamorphism and exhumation. Ar-Ar dating of biotites and muscovites yielded plateau ages of 335.75±0.8 Ma and 331.56±0.8 Ma; respectively; indicating Early Carboniferous metamorphism and exhumation of the middle slice. These ages also constrain depositional age of the cover sediments to between 444 Ma and 335 Ma.

The new geochronological data obtained reveal; for the first time; the presence of Late Cambrian-Early Ordovician magmatism in the Sakarya Zone. This Early Palaeozoic magmatism is considered to have formed in response to rifting of the Sakarya Zone crust from the northern margin of Gondwana. We propose that the Middle to Upper Paleozoic meta-sedimentary cover was deposited on extended continental crust during and after rifting of Paleotethys. After transiting Paleotethys the Gondwana-derived Central Sakarya terrane was accreted and metamorphosed at the southern margin of Laurasia during the Early Carboniferous. Granitoid rocks were then intruded during the Late Carboniferous; as part of the Pontide active continental margin.

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The Söğüt Metamorphics are interpreted as the pre-Variscan basement of the Sakarya Composite Terrane. In the Central Sakarya area, the unit outcrops as slivers of an E-W trending belt disconformably overlain by the Jurassic Bakırköy Formation and Bilecik Limestones on the north. The Sakarya Metamorphics are thrust via the Tuzaklı-Gümüş fault onto the Tertiary rocks in the south, which in turn disconformably overlie the ophiolitic mélanges of the İzmir-Ankara Suture Belt. The Söğüt Metamorphics are intruded by the early Carboniferous Sarıçakaya Granitoid; which is elongated E-W and consists of blasto-mylonitic granodiorite; quartz-diorite; and granite; cut by pink aplitic and pegmatitic dykes. The Sarıçakaya Granitoid displays calc-alkaline; I-type geochemical features and is interpreted to have formed in a magmatic arc setting. The age of the Söğüt Metamorphics are interpreted as pre-Carboniferous based on the U-Pb zircon ages obtained from the intruding granites (319-327 Ma). The mafic and ultramafic rocks are observed as bands; lenses; boudins or tectonic slices with highly sheared contacts within the host ortho- and para-gneisses having E-W trending foliation. The dominating rocks are amphibolites that were affected by the amphibolite facies metamorphism together with their host gneisses. The peak metamorphic conditions are defined by the cordierite-sillimanite-biotite paragenesis of the para-gneisses. The presence of migmatite fabrics in amphibolites and their host rocks; both in outcrop and thin-section scale is indicative of partial melting conditions. Overprinting retrograde metamorphism is defined by epidote-chlorite-muscovite paragenesis. Considering their field relations and petrographic features; amphibolites were divided into two protolithic groups as “fine-grained concordant amphibolites” and “coarse-grained metabasalts”. The next group of mafic and ultramafic rocks; on the other hand; are boudins of melano-and leuco-gabbro and serpentinite with well-developed cumulate texture. They were previously named the “Tozman Metaophiolite” and occur as discontinuous lenses; tectonically incorporated into the Söğüt Metamorphics. In this study; both unit’s preliminary metamorphic and petrologic features; petrogenetic correlation; and possible emplacement mechanism are discussed on the basis of field and petrographical observations; which will be later combined with the geochemical studies.

This study is funded by Eczacıbaşı ESAN.

Keywords: Söğüt metamorphics; Tozman metaophiolite; amphibolite; petrography; migmatite
Tracing Triassic arc magmatism and related provenance variation along the Palaeotethyan active margin: Combined U-Pb and Lu-Hf isotopic evidence of detrital zircons in sandstones from the Tokat Massif (central Pontides) and the Ankara Mélange (central Anatolia)

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Using U-Pb-Hf isotopic analysis; detrital zircons have recently been studied from sandstones of the Permian-Triassic active continental margin in northern Turkey; represented by the Karakaya Complex in the Tokat Massif and the Ankara Mélange farther east. A key question is whether Triassic arc-type source rocks; which characterise the sandstone provenance in the type Karakaya Complex area (Biga Peninsula; western Pontides) also contributed sediments to the active margin further east. Our resulting analytical data indicate that Triassic arc-type magmatic source rocks supplied sediment all along the active margin; a distance of >1000 km. In addition to Triassic arc-type source rocks; Permo-Carboniferous and Devonian igneous rocks also supplied detritus to the sandstones throughout. Despite this; there are some significant changes in provenance eastwards. First; the relative abundance of Precambrian zircons increases considerably in the east. Secondly; crustal melts that supplied the Triassic and Late Palaeozoic igneous source rocks are mixed with much older; Neoarchean to Palaeoproterozoic-aged crust; unlike the source rocks of the westerly (type) area. Thirdly; the Hf data indicate that; in addition to old crust; juvenile crust formation took place during Late Palaeozoic-Early Mesozoic time and was recycled during subsequent magmatic episodes. The overall isotopic characteristics of the Karakaya Complex sandstones are consistent with an increase in crustal thickness of the source area from west to east.

Our new isotopic data also suggest that the maximum age of deposition of most of the sandstones in the Tokat Massif and the Ankara Mélange is Norian (latest Triassic). Also; some units that are traditionally considered to be Permo-Carboniferous (e.g. Geyraz Formation in the Tokat Massif) should instead be Late Triassic because zircon grains of this age are present. The maximum depositional age of the structurally uppermost melange unit in the Tokat Massif (Karasanir Formation); which is traditionally considered to be Silurian; appears to be Permian; again based on the youngest detrital zircons present. Our combined results support a new regional synthesis in which a Triassic continental margin arc developed along at least 1000 km of the Palaeotethyan active margin in northern Turkey. However; no trace of this arc is known from north of the Pontides or from the Anatolide-Tauride block farther south. Possible explanations are that the Triassic arc was later subducted; displaced laterally; or concealed by collision-related thrusting.

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Keywords: Sandstone; Provenance; zircon; U-Pb-Hf isotopes; Triassic; arc magmatism; palaeotethys; Tokat massif; Ankara melange
Highlighting ductile deformations in the Chahna region (Small Kabylie - Algeria)

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The center of the basement of small Kabylia belongs to the internal domain of the Maghrebids chain; it shows the upper unit constituted by metapelites passed from marble and intruded by deformed granites. These metapelites are Biotite; Muscovite; Chlorite; and the deformed granite is quartz in the form of almonds; plagioclase (oligoclase) and biotite; which underlines the shear zones. The metapelitic series that initially crystallized in the green schist facies has undergone a prograde evolution with the appearance of the Bio + Gt pair; which testifies an amphibolitic facies (A. Afalfiz; 1990).

The structural study of the region shows that the entire Kabylian basement has been spalled from NW to SE; the metapelitic series records two fold directions; the first direction NW-SE while the second direction NE -SW (A. Afalfiz; 1990). The granitic body shows two main deformations; the first is a homogeneous deformation; the analysis of the C / S planes gives a sinistral shear direction NW-SE and a deformation of N towards the S. The second deformation is heterogeneous; it is N-S direction; it concerns the intensely deformed zones; C/S planes are superimposed. The stereographic projection of the conjugate fault planes gives normal faults N-S direction; this deformation is parallel to the schistosity planes of the metapelites; it materialized by tight folds lying towards the S and towards the N. the sigmoidal elements from the metapelites record sinistral shear towards W and strain stress NW-SE.

In conclusion; the Chahna region shows the shelling of the Kabylian basement related to shortening movements NW-SE; NE-SW; the granite body records an N-S extension direction represented by shearing ductile deformations while its metapelitic shell shows uptight folds lying down. These structures have recorded in all the granites of small Kabylia (Sidi Abdellaziz; Sidi Ali and Beni Khettab); they are in favor of the formation of gneissic dome. These structures were highlighted in the Granite of Sidi Ali Bounab in Great Kabylia (A.Saadallah et al; 1996) and in the Alpujarrides; Betic Cordillera; SE Spain (Orozco et al; 2017); studies in these different regions agree on the alpine age at these different deformations.

Keywords: shear; metapelites; deformation stress; Maghrebids; small Kabylie
Tectonic analysis of South Setifian domain and its neighbor areas (Eastern Algeria)

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The present study focuses on area located at the southern fringe of external zones of eastern Algeria Alpine belt; situated on the Aures meridian (Batna). In this area; fracturing is well developed; although; vegetal cover masks often structural and geological informations. This study aims to enhance the identification of major accidents and their associated geological structure in order to facilitate mapping by using Landsat satellite images and SRTM DEMs.

Structural analyses undertaken in this work have permitted to get new results specifying or modifying the results obtained by our procedures. We can distinguish two types of folds: faulted-folds; in the northern part of the study area and propagation folds in the southern area. All anticlines associated to overlaps are verging south and we can not extend them to tangential tectonics.

The validation of these results was made on the basis of existing geological maps and photogeology and field knowledge.

Keywords: Algeria; satellite images; SRTM DEMs; structural analysis; folds
Scientific Session A.2

Sedimentology, Biostratigraphy & Palaeoecology of Depocenters in the Eastern Mediterranean Region

Conveners:
Dr. İsmail Ömer YILMAZ; Dr. Funda AKGÜN;
Dr. Faruk OCAKOĞLU; Dr. Bilal SARI
Biostratigraphy and sedimentary discontinuities of the Lower and Middle Jurassic carbonate platform of Ouarsenis massive (Tell, West Algeria): causes and effects

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The Jurassic history of the Great Peak of Ouarsenis is marked by local tectonics which has caused the differentiation of an irregular paleogeography, an inheritance of the early phases of tethysian rifting. For this purpose, important interruptions have been recognized in the Jurassic. Two intra-Carixian discontinuities were recorded; one within the internal platform, the second ends a small cycle transgression-regression. The pre-domerian discontinuity precedes the generalization of the external platform conditions. Finite-Domerian discontinuity evolves from the lagoon subtidal to the outer platform. The discontinuity of the late Middle Toarcian undergoes a slowing down of sedimentation and results in a gap in the Upper Toarcian at the beginning of the Bajocian. The pre-Humphriesianum discontinuity marks the resumption of sedimentation with the "pink entroquites". The particular silico-clastic sedimentation of terrigenous origin is deposited in the submarine cone and testifies to the reactivation of the tectonic rift liasique. The pre-Niortense discontinuity records a stage of deepening with the appearance of "Silex limestones" and "Zoophycos limestones". The post-Garantiana discontinuity affects "filament limestones". The general deepening leads to erase the barrier role played by the shoals. The deepening and the new eustatic rise of the Bajocian heals and erases the previous structure.

Keywords: platform, discontinuities, Jurassic, synsedimentary tectonic, Ouarsenis.
The presence of pedogenic processes in Permian red clays, in South-Hungary

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The study of the Boda Claystone Formation (BCF), one of the potential host rocks for radioactive waste disposal, and its geological environment, the Western Mecsek Mts (Hungary) dates back to several decades. To decide on the location of the suitable disposal area, a detailed knowledge of the geology of the formation is necessary. The homogeneity of the formation is an important aspect of the high-level radioactive waste disposal point of view. With the help of the cyclostratigraphy and sedimentology we gain information about the homogeneity which is a priority. The investigated sediments were deposited simultaneously with the end of the Permo-Carboniferous ice age. The main goals of my research are the clarification of climate change and the palaeoenvironment during the mentioned period. The detailed knowledge of the build-up of the succession help to improve the climatic model. Understanding the processes is essential, to understand the natural causes of climate change after the ice age.

Understanding the driving force behind climate change is a current issue, which also affected by orbital changes. An essential question of the present research is the investigation of the environmental role of paleosols development. The former soil development processes only started under certain climatic conditions in particular basin situation. If we gain information about these processes, we can have a good chance to conclude future climate change affecting us.

The red clays in the succession are typically paleosols, which, according to the literature can be associated with the arid/semiarid climate, and this issue has not yet been clarified for the investigated succession. The so-called “disturbed structured” clayey siltstone/silty claystone represents the paleosol horizons. The silty claystone, which composes the major part of the sequence, lost their primary structures due to pedogenic processes and indicate prolonged subaerial intervals with soil formation and only ephemeral inundations. The presence of pedogenic carbonate concretions supports the interpretation of an arid climate and a relatively shallow groundwater table. To clarify this question, we have carried out micromorphological studies, as well as the reinterpretation of a large number of available thin sections. The number, maturity, and thickness of paleosol horizons are well known as good palaeoenvironmental indicators in similar environments as the BCF depositional basin.

Calcrites and dolocretes are important environmental indicators according to literature, while they can appear between the playa mudflat and the alluvial debris fan. It was necessary to reconsider the autogene breccia type sediments, while it’s origin is not clear so far. They could be considered as a result of plant root activities.

By answering the previous key questions it was possible to clarify the palaeoenvironment (presumed playa mudflat) position and role of the interfingeri ng formations. The BCF interfingers at the basin margins with the underlying and overlying formations (Cserdi and Kövágószőlős Formations) as a heteropic basin facies. The paleosols developed near or in the playa mudflat, where it meets (interfingering) with the alluvial debris sediments.

Keywords: Boda claystone; paleosols; climate change; claystone; Permian
Vegetation cover of oceanic islands in Neotethys Ocean during Late Cretaceous is almost unknown due to lack/less outcrop of terrestrial to very shallow marine facies in the Eastern Mediterranean. Here we present some sedimentological and palynological data collected across a submarine fan system of middle Campanian age from the Central Sakarya Basin, NW Anatolia. According to this pioneering palynological study, Late Cretaceous (Santonian-Campanian) age determination based on the palynomorph assemblage of Nallihan is supported by nannoplankton fossil data (zone CC21). This assemblage was dominated by fern spores, with a diverse component of angiosperm and a few gymnosperm pollen. The angiosperm association consists of Normapolles (e.g. Nudopollis, Oculopollis and Trudopollis) and Post normapolles (e.g. Subtriporopollenites and Triporopollenites) type pollen grains. All palynological data throughout the section reveal the presence of a strong terrestrial vegetation.

The diversity and abundance of dinoflagellate cysts (e.g. Surculosphaeridium longifurcatum, Achamosphaera ramulifera and Odontochitina porifera) observed in the lower part of the section indicate that sedimentation occurs in shallow sea conditions. The high numbers of the gonyaulacoid over the peridinioid cysts supports inner-shelf depositional environment. Upward along the section, an increase in terrestrial flora input and small changes in dinoflagellate abundance are observed.

**Keywords:** palynology; Campanian; Sakarya Archipelago; Nallihan
Afsar, preliminary results of a new Pliocene vertebrate locality in the Sandıklı Basin (southwestern Anatolia)

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Anatolia has a great number of vertebrate fossil localities. However, its published fossil record is limited. This holds particularly true for the Pliocene; this time period has overall received less attention by the scientific community. Whereas our current understanding of the Anatolian Pliocene is scanty at best, on the other side of the Aegean Sea, in Greece, we have a more complete image of events. So far, the Pliocene of the Mediterranean was mostly known from an extensively studied section in northern Greece. However, over the last decade, a large number of late Neogene and early Pleistocene localities were discovered by a team of MCA (Pamukkale University) in cooperation with Natural History Museum of Ege University (SM) and Naturalis Biodiversity Center while creating a detailed stratigraphy of the south-western Anatolian basins. These localities yielded a large number of micromammal fossils. The new localities open unique opportunities to expand our knowledge on the Pliocene of the Aegean domain and refine the dating of terrestrial sediments in the area.

A Turkish key for the study of the Pliocene of Anatolia is the Çameli Basin. It is located in southwestern Anatolia and is notable for containing several non-marine fossil localities of Plio-Pleistocene age. This basin is filled with sediments dated back from the Neogene to the Pleistocene. These sediments represent different types of environment in an obvious lacustrine succession. From this basin the localities of Ericcek and Beçakçı were published and many others which are currently under excavation. In addition, the newly discovered locality of Afsar from the Sandıklı Graben to ca. 200 km NE of Çameli basin is of special importance. This section includes various fossiliferous layers with a great variation in micromammal taxa and species.

This study is part of a PhD thesis focused on Anatolian micromammal remains during the Plio-Pleistocene. Micromammals, and in particular rodents, are excellent stratigraphic markers and palaeoenvironmental indicators. Apart from the biostratigraphical studies, we will pursue absolute dating from the different localities by tracking volcanic ash layers, which are quite frequent in this tectonically active area. Finally, for this study strong time control and sufficient localities are essential. As such, the Ptolemais sections which have been previously published, play a pivotal role by having both radiometric dating and a strong correlation to the geomagnetic polarity time scale.

Preliminary studies of Afsar locality showed the presence of Muridae, Arvicolidae, Gliridae, Spalacidae, Sciuridae and various genera of insectivores. In addition, in the top layer large mammals have also been found including equids (Hipparion), cervids and carnivores (Baranogale). The large number of fossils from different layers representing different time periods will give a detailed image of the evolution of the included species and the stratigraphy of the locality.

Keywords: Anatolia; palaeoenvironment; micromammals; palaeobiogeography
Plio-Pleistocene marine and terrestrial transitions of the Datça Basin, SW Turkey

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Datça Peninsula is a WSW-ENE trending linear landmass located at the SW corner of Turkey. It separates the Mediterranean Sea from the Gökova Bay, the south-easternmost extent of the Aegean Sea. The peninsula is divided into three almost equal parts where the Datça Basin constitutes the central part. The infill of the Datça Basin comprises Plio-Quaternary units resting on the Mesozoic carbonates, clastics and ophiolites belonging to the Lycian Nappes. The infill units include continental to marine transitional deposits intercalated with two successive air-fall ash layers. Nevertheless, high-resolution stratigraphic relationships, facies associations and precise depositional age and timing of the basin fill are still under debate. In this context, we conducted detailed palaeontological, stratigraphic and sedimentological studies in the basin to better understand its evolution. This will provide new information in understanding the evolution of SW Anatolia and Eastern Mediterranean geology.

For this purpose, a 300 m-thick composite section was logged in detail and sampled. In addition, more than 50 samples were collected from various locations within the basin. Our preliminary observations indicate that the bottom of the basin infill is represented by fluvial conglomerates that laterally grade into thick-bedded lacustrine limestones at the northern side of the basin. These successions are overlain by cyclic alternations of fluvial sandstones and conglomerates. In the middle part of the section, the first marine incursion was observed. The thickness of the marine layer laterally changes from 1 to 4 m. This part is dominated by pelecypod fauna, *Crestoderma* sp. In addition, in the eastern part of the basin the marine level is represented by *Venus* sp., *Pecten* sp., *Anadara* sp., and *Abra* sp. accompanied by benthic foraminifera, *Ammonia* sp. A second marine transition is located 30 m above this horizon and is dominated by *Ostrea* sp. In between these two marine layers, river incisions can clearly be observed which are possibly due to a relative sea-level drop. These incised fluvial deposits are composed predominantly of cross-bedded conglomerates and sandstones. They have both very sharp and transitional contacts in places. These sequences are overlain by fluvio-lacustrine deposits consisting of freshwater pelecypods and gastropoda fauna. At the top of the section, in the western margin of the basin, the youngest marine deposits characterized by the *Ostrea* sp. rest on these units.

It is obvious that marine incursions took place from the southeastern margin of the basin, i.e. from the Mediterranean Sea. This is evidenced by the absence of foraminifera and the increase of the diversity of brackish pelecypod fauna in the northern parts of the basin. It is possible that some of this brackish fauna in the north might be related to marine incursions from the north, however, the absence of foraminifera in these sections supports southerly incursion. Likewise, Kos Basin has marine ingressions evidenced by *Cardium* sp. levels. Although the island has more marine influences, the Plio-Pleistocene section is sealed by fully marine horizons at the eastern part of Kos as observed in the Datça Basin.

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**Keywords:** paleoenvironment; pelecypod; foraminifera; marine influence; Datça Basin; SW Anatolia.
In the light of the Middle Miocene Palaeoflora and Palaeovegetation in Muğla-Tıran (Western Anatolia)

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In southwestern Anatolia, the sedimentary deposits contain the plant remains that formed in a coal bearing lacustrine depositional setting. This study is based on detailed palaeobotanical investigations of the middle Miocene coal deposits, specifically exposed in the Yatağan-Tıran Basin in Muğla and its surroundings. Unfortunately, the well-preserved leaf fossil flora is currently threatened by extensive coal mining activities in the Tıran coal mining area. During this study, we finish the detailed study of palaeobotanical analyses of the leaf fossils collected from the Sekköy Formation that contains the main coal seam at the bottom and marls in the upper parts in this basin. 1132 identifiable macrofossils were collected from marls of the Sekköy Formation. In these samples, 13 algae, 2 ferns, 23 gymnosperms and 1094 angiosperm fossil samples were identified. The gymnosperms comprise of 3 taxa from 2 families, the angiosperms comprise of 76 taxa from 13 families (including 2 monocots and 74 dicots). In total, 300 specimens could not be identified and remained undetermined. According to this macro floral study, during the middle Miocene, the Tinaz Basin enjoyed a temperate climate that nurtured broadleaf deciduous forests.

Keywords: Leaf Fossils; Miocene; Yatağan-Tinaz
Morphologic development of the Gediz River Mouth, Aegean, Turkey

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River mouths are the environments where the delta evolution starts. The system develops under the control of the sediment dynamics and energy potential. Understanding the dynamics of these systems is vital for accurate stratigraphic interpretation. The purpose of this study is to understand the evolution of the Gediz delta system, which is the largest freshwater source of the Gulf of Izmir and the second largest river flowing from Anatolia to the Aegean Sea with its 17,500 km² catchment basin. Furthermore, the Gediz delta is a large wetland area of over 40,000 hectares, consisting of bays, freshwater marshes, salt marshes, large salt pits and lagoons. The average annual flow rate of the river is 60.48 m³/ sec and the significant wind direction at the river mouth is north-northeast (NNE). The path of the Gediz River has been changed in the last few hundred years. In 1886, the direction of the river was changed in order to prevent the Izmir port silting up. Until 1886, the river was about 50 km west from the Izmir. Afterward, in 1963, the course of the river was changed again due to shoaling. Galloway classification was used which classifies the delta depositional systems into three categories as river-dominated, wave-dominated or tide-dominated, using five indicators. These indicators comprise of morphologic and geometric information of river, additionally sediment compositions and two structural components of the river mouth. All these components reveal that the Gediz River has the river dominated-wave modified depositional delta system. This classification shows that the river depositional system is shaped by the wave effect as it moves forward, which can be seen as a result of changes in the flow rate of the river over the years. The result is also supported when the change in delta coastline is considered. This change shows that the Gediz River is moving towards the sea, with a wave effect directing the river to the east.

Keywords: river dominated; wave dominated; delta depositional systems
Chem stratigraphy of marble association in the Kazdağı Massif (Western Anatolia)

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Medium to high-grade metamorphic rocks of the Kazdağı Massif form one of the most complex stratigraphical structure in terms of age-determination. White, coarse-grained dolomitic to ammonitico-rosso-like facies unconformably overlie the metaultramafic rocks of an oceanic crust. This marble association gradually pass upward into a migmatized metaclastic association with mafic lava, marble intervals and preserved metagranitic bodies. Metaclastic structure and the migmitization history of the Kazdağı Massif gave rise to yield complex radiogenic-ages to put forward the formation ages of the Kazdağı Massif. Therefore, non-conventional isotopic methods are needed to give an age estimation for such metamorphic complexes.

In this study, we perform Sr-O and C isotopes from the marble association of the Kazdağı Massif. The marble samples were selected from the ones which is stratigraphically well-known location, clearly coarse-grained calcite-marble and initial Sr-values are compatible. The calcite marbles are also verified by XRD, SEM (BSE and CL images) and geochemical (whole-rock) analysis. From those marble samples, we employ Sr-O and C isotope analysis to apply con-conventional dating methods by using the isotopic values in comparison with the global sea-water isotopic trends. In addition to that, high resolution Sr-isotope values, vary between 0.7071475-0.7077331, from the Kazdağı marble association were verified by internal standard which was collected from non-metamorphic carbonates of the Karakaya Complex. According to the isotopic results, depositional age of 184-207 Ma (Norian to Plansbachian) is calculated for the marble association of the Kazdağı Massif.

Consequently, all the chemostatigraphy data collected from the calcites of the Kazdağı Marble and with the support of stratigraphical features of the Kazdağı massif verify that the metaplatform of the massif is compatible with the Mesozoic platform sequence of the Sakarya Zone. Moreover, it is unlikely to conclude that the Kazdağı Massif had undergone poly-metamorphic stages.

Keywords: Kazdağı Massif; chemostatigraphy; Sr-O-C isotopes; high-grade metamorphism
Carbon-isotope stratigraphy of the Cenomanian-Turonian carbonate succession of the Türkoğlu section (SE Turkey): implications for the timing of Late Cretaceous sea-level rise and anoxic event

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A carbon-isotope stratigraphy of the upper Cretaceous shallow and deeper water Cretaceous limestones from Türkoğlu section, SE Turkey, has enabled accurate definition of the Cenomanian-Turonian boundary. Carbon-isotope stratigraphy of this succession revealed a positive shift $\delta^{13}C$ values that reached +1.97% and represent the CTB interval excursion (OAE2). The sediments close to the boundary show pelagic influence registered by the presence of planktic foraminifera. These results spotlight the potential use of carbon isotopes as a dating and high-resolution correlative tool in shallow-water carbonate rocks and help elucidating the timing of oceanographic events affected the area that we studied. In particular, it is suggested that the highest rate of a relative, possibly eustatic sea-level rise took place during the latest Cenomanian, that was followed by the global oceanic anoxic event during Cenomanian-Turonian boundary (CTB) interval, and that peak transgression or maximum flooding was achieved during the early Turonian in this region.

Keywords: carbon-isotope stratigraphy; sea-level rise; Cenomanian-Turonian boundary (CTB); OAE2
An Upper Cretaceous platform carbonate succession outcrops in the Belkahve and Işikkent areas of the Bornova Flysch Zone. The Belkahve section starts with the Cenomanian limestones which include a poor benthic foraminiferal assemblage. It shows a continuous Cenomanian–Turonian shallow–water carbonate sedimentation which is not common in peri–Mediterranean platforms. A similar case was also recorded in the Apennines and Bey Dağları Platforms. The *Pseudocyclammina sphaeroidea*–*Keramosphaerina tergestina* interval zone is defined from the Turonian–Coniacian rudist-bearing limestones. The *Keramosphaerina tergestina* assemblage zone assigned to the lower-middle Santonian is characterized by *Keramosphaerina tergestina* and *Urgonina*. The conformably overlying the upper Santonian pelagic limestones are characterized by the *Dicarinella asymetrica* assemblage zone and it is unconformably overlain by the Maastrichtian bioclastic limestones. Due to this unconformity, pelagic limestones are not found in the Belkahve and bioclastic limestones directly overlie the *Keramosphaerina tergestina* assemblage zone. The Maastrichtian limestones are truncated by a surface which is interpreted herein as hardground. Bornova flysch covers this surface with a stratigraphic contact. This stratigraphic contact shows that the Mesozoic carbonate successions in the BFZ were deformed together with the Bornova flysch. This is contrast to previous opinions that they are giant limestone olistoliths or allochthonous blocks.

**Keywords:** Benthic foraminifera; Upper Cretaceous; Bornova Flysch Zone.
Lithostratigraphical and sedimentological characterization of the Aptian formation on the Northern flank of Dj Bou Arif (NE of Algeria)

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A stratigraphical and sedimentological facies approach has been applied to the study of the Aptian series of the menchar ali guera section, which is located on the northern flank of Dj. Bou Arif (NE, Algeria). Two lithostratigraphic sets can be distinguished, at the base there are black marls that have delivered only a bad micraufauna with Cythereis blaterensis and Schuleridae. These marls superimposed in the lower Gargasian. At the top, marl-limestone intercalations with Oribitolines are found at the base of the upper Aptian carbonate bar.

The base of the carbonated bar shows fine microfacies with Acicularia microfilariae, Haplophragmoides sp., Ammobaculites sp., Cuneolina sp., Valvulammina sp., Orbitolina sp., Boueina sp., Miliolidae and Ostracods. It implies therefore to the upper Aptian.

The sedimentological study of this series made it possible to highlight three microfacies in which the association on the deposit profile defines: a domain of internal intertidal platform-shoal level. It is characterized by microsparitic packstone microfacies with orbitolines and echinoderms, an orbitoline and miliolid biomicritic mudstone, and a high energy oolitic grainstone microfacies characterizing the shoal domain.

The vertical arrangement of the facies along the studied section revealed a phase of transgression dominated by the marls covering the base of the Aptian followed by a regression phase in the terminal part representing by marl-limestone intercalations.

Keywords: Aptian; Bou Arif; microfacies; microfauna; transgression.
A2-16

The Campanian-Maastrichtian series of Dj. Gaâga (Tebessa, NE of Algeria): quantitative and qualitative analysis and palaeoenvironmental interpretation

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The upper Cretaceous deposits, characterized by significant extension within the eastern Saharan Atlas of Algeria. A micropaleontological study allowed us to give to Dj. Gaaga the Campano-Maastrichtian age. A lithostratigraphic survey and a sedimentological analysis of these sediments made it possible to distinguish three formations (marl-limestone, marl and limestone) aged from middle-Campanian to late Maastrichtian.

Paleoenvironmental analysis, based on the count of microfauna (planktonic, benthic foraminifera and ostracods) and especially the dominance of planktonic foraminifera indicate a deep pelagic to hemipelagic marine environment; started from the meso-bathyal zone of the continental slope in the first formation pointing at 800 m depth, this is indicated by 70 to 87% of planktonic foraminifera with a large number of keeled specimens. In the second formation, the environment passes to an epi-bathyal zone (290 m). The depth gradually decreases in the third formation, shown by a powerful limestone formation. The sequential analysis of this series shows the superposition of 3 sequences of deposits (sequences of 3rd order). The first is Campanian (S I) while the last two are Maastrichtian (S II and S III). Each of these sequences is, in turn, split into several sequences of 4th order or parasequences.

Keywords: Algeria; quantitative; foraminifera; sequence; Cretaceous
Stratigraphy and tectonics of Kastas Hill and broader area, Strymon basin, Northern Greece

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The integration of tectonic, stratigraphic, paleontological and sedimentological observations, contributed to the study of the Neogene sequence in the area of hills Kastas and 133, situated at the south-eastern part of Strymon basin, Northern Greece. They consist of Neogene (Miocene and Pliocene) sediments that also infilled the entire Serres-Strymon basin. Hill 133 appears to be a horst, causing localized uplift, resulting in the lower part of the sequence to outcrop at the foothill. It consists of grey clays containing ostracod fauna, indicating a lacustrine brackish environment during Miocene. The upper part of the sequence, outcropping on Kastas Hill, consists of clastic sediments, characterized by the Pliocene zonal marker Pecten reghiensis, accompanied by benthic and planktonic foraminiferal fauna, suggesting a marine depositional environment. The transition from lacustrine brackish to marine (molluscs, benthic and planktonic foraminifera) fauna, points to a rapid sea level rise, and although our study area is situated at the basins’ margin, the fauna suggests a marine environment in connection with the relatively deep Strymonikos Gulf southwards, during early Pliocene.

**Keywords:** Neogene stratigraphy; tectonics; Kastas Hill
Clay minerals of Van Formation (Turkey): Implications for climate of middle and upper Miocene in East Anatolia

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The Oligo-Miocene aged lithostratigraphic unit which widely crops out around Van is called as Van formation. Sedimentary rocks of Van formation indicate depositional environments changing from carbonate shelf to basin with their features. Van formation was evaluated sedimentologically, stratigraphically and palaeontologically in the former studies. In this study, it is aimed to determine the mineralogical composition of the Middle-Upper Miocene aged clayey rocks of the Van formation and to interpret the paleoclimate conditions during the time of deposition. The study area is located in the East and Southeast of Lake Van and covers an area of approximately 165 km². Four stratigraphic sections were measured from the Middle-Upper Miocene interval and 73 clayey rock samples were collected along these measured stratigraphic sections in the study area. All samples were analysed by X-ray diffraction to identify mineralogical composition (bulk and <2 μm fractions after heating at 300–500°C and ethylene glycol solution) using CuKα radiation (Panalytical X'Pert Powder). Quartz, feldspar, mica, clay minerals, calcite, dolomite, amphibole and cristobalite were determined in the bulk samples. Clay fractions include smectite, illite, chlorite, chlorite-smectite, illite-smectite and serpentine as clay minerals; quartz, feldspar, calcite and amphibole as non-clay minerals. Scanning electron microscopy (ZEISS Sigma 300) and EDX studies were performed on three selected samples using ZEISS Smart EDX. In these samples, clay minerals such as serpentine, chlorite and smectite were observed. The source rocks of all these inherited minerals are Paleozoic, Mesozoic and Cenozoic (Paleocene, Eocene) age limestones, ophiolite rocks and metamorphic rocks. Because of the coexistence of well crystallized illite, chlorite, smectite and feldspar minerals, the climate in the region in which detritic sedimentary rocks of Van formation were formed is interpreted as cold, continental climate similar to the conditions prevailing today.

Keywords: climate; East Anatolia; Middle-Upper Miocene; mineralogy; Van; xrd
Early Messinian (Late Miocene) stratiform manganese deposition in a hemipelagic carbonate-depositing basin (NE Cyprus)

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The late Messinian salinity crisis in the Mediterranean, associated with eustatic sea-level fall, desiccation and evaporite accumulation is internationally famous. During the preceding Messinian time interval (c. 7.25-5.97 Ma), a wide range of bathyal to shallow-marine and even hypersaline deposits accumulated, including pelagic and hemipelagic carbonates (marls), organic-rich muds (sapropels), siliceous deposits (diatomites) and localised marginal evaporites. Here, we discuss an unusual occurrence of stratiform manganese deposits within early Messinian (<6.82 Ma) hemipelagic carbonates. The Messinian-aged manganese deposits occur as six main laterally continuous beds (up to 80 cm thick) within hemipelagic carbonates in the NE of the Kyrenia Range. An additional section in the NW contains many more, but thinner, manganese-rich layers. The manganese-layers in the NE are dominated by poorly crystalline manganese oxy-hydroxide (birnessite), with associated mild enrichment in some trace elements (e.g. Ba, Ni, Cu, Mo, As, U). Background minerals are mainly magnesian carbonate, together with minor kaolinite, chlorite, mixed-layer clays and talc (serpentinite-derived). The manganese accumulated during a time of initial isolation of the Mediterranean Sea from the Atlantic Ocean but prior to major sea-level fall and evaporite precipitation. A small, silled marginal-marine basin is inferred to have existed between a tectonically-controlled E-W ridge to the N (future Kyrenia Range) and a deeper-marine basin to the south. This marginal basin alternated between, first, well-mixed and oxidising, and, secondly, stratified and oxygen-depleted (at depth). Manganese entered the basin following pedogenesis in a fluctuating warm-wet to warm-semiarid climate. After entering the marine basin, the manganese was retained in solution below the chemocline during stagnant low-oxygen periods. Manganese oxy-hydroxide (and associated trace elements e.g. Mo>U) accumulated, together with hemipelagic carbonate, during periods of oxidising seawater influx. To allow the repeated formation of manganese layers, with up to c. 20% MnO, we suggest that soluble manganese fluxed upwards from a sulphidic environment beneath. A possible source reservoir was Messinian-aged sapropels (organic-rich sediments), as exposed in another section. The manganese precipitation events diminished with time, giving way to well-oxygenated hemipelagic carbonate accumulation, with bioturbation and a shelly infauna. Gypsum appears abruptly upwards above the hemipelagic sediments in a nearby section. The unusual Mn deposition records an extraordinary interplay of tectonically-controlled basin formation (regional to local scale), changing ocean hydrology, climatic change (local to regional), chemically suitable source rocks, and also possibly an upward supply of dissolved manganese from sapropels during diagenesis. The regional tectonic setting of the Messinian-aged (pre-evaporitic) basin formation in N Cyprus relates to the latest stages of northward subduction of the Southern Neotethys, as a precursor to collision of the African and Tauride (Eurasian) plates. Are any similar manganese-rich layers present in Early Messinian deposits in Turkey or elsewhere in the Mediterranean region?

Keywords: manganese; N Cyprus; Messinian; geochemistry; basin model
Seasonal to Milankovitch band cyclicity from the Eocene oil-shale bearing lacustrine succession in the Central Sakarya Basin: constraints from multi-proxy data

Faruk Ocakoğlu

Hatılg area in the Central Sakarya Basin (NW Anatolia) comprises a 250 m thick lacustrine to lagoonal Eocene sequence. The sequence is typically formed from repeated lithological alternation of limestone→marl→bituminous shale. Spectral analysis on the basis of facies types and thickness of this unit revealed 2.1-2.3 m thick precession cycles across the basin. To investigate the nature of sub-Milankovitch cyclicity, we logged a 13 m thick section (grossly 5 precession cycles), sampled it at high resolution (5 cm/sample in average), and analyzed them for MS, d18O, d13C, some major oxides, and organic elements. Additionally, a microscopic investigation on the finely laminated marl/mudstone intervals was also carried out. Thin section studies revealed individual cycles made from gray (carbonate-rich) and yellow (organic-rich) bands of 0.2-0.8 mm. We also observed that 9-10 individual cycles come together to form bundles. Comparison with the thickness of precession cycles indicates that these individual microscopic cycles would be annual. Stable isotopes of O and C have good fit with the lithology, so that the carbonate levels display more negative values of d18O while the mudstone and shale intervals display more positive shifts. A strong co-variance between d18O and d13C furthermore indicates the mutual control of these proxies by the water temperature. Analytical results indicate that carbonate deposition in this marginal marine realm occurred rather in interglacial warm periods while the mudstone and bituminous shale precipitation preferred the glacial periods. The present study also demonstrates that the paleo-temperature variations in individual cycles are very high (i.e. >10 °C, or 4-5 permil). These results are considered surprising under the light of ice-free Eocene paradigm.

Keywords: Eocene climate; Milankovitch cyclicity; Central Sakarya Basin; stable isotopes
Preliminary approach to paleogeographic properties of Edremit (Van) Travertines, eastern Turkey

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The Lake Van Basin (east of Turkey), located on the Eastern Anatolian Plateau, is the product of the compression regime that was effective after the continent-continent collision between Eurasian and Arabian plates. The basin is located in a region where tectonic activities have taking place. As a result of these tectonic activities, fissure-ridge type, self-built channel type, terraced-mound type, layer type travertines were formed in the region.

In this study, paleogeography of the Edremit Travertines has been investigated by examining sedimentological characteristics, environmental characteristics and formation times together. In this context, six lithofacies such as crystalline crust facies, reed type facies, shrub type facies, lithoclast-breccia facies, paper-thin raft type facies and paleosol facies were distinguished in the Edremit Travertines. When all these lithofacies and their formation times are evaluated together, it is determined that layer type travertines were formed between 542.34 ka and 115 ka in the lower slope environment and tufas representing the lacustrine environment characteristics were formed between 24.78 ka and 5.74 ka (U/Th ages). When all the formation parameters are taken into consideration, it is determined that the formation of travertines occurs in three different periods. The boundary between travertines and scales could not be determined, because of plant cover, human settlements and raw material quarries.

Keywords: Lake Van; morphology of travertines; facies of travertines; tufas
Maastrichtian drowning of a carbonate platform within the Bornova Flysch Zone (Spil Mountain, Manisa, western Turkey): Preliminary data based on dasyclad algae and planktonic foraminifera

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Uppermost level of a well-preserved Cretaceous-Paleocene outcrop from the Spil Mountain (Manisa-western Turkey) yields data for onset of pelagic deposition on a drowned carbonate platform within the Bornova Flysch Zone. The succession in the Atalanı locality comprises six lithostratigraphic levels. 13-m-thick neritic part (level-1: well-bedded limestones, and level-2: massive-bedded limestones) at the base of the succession is made up dark grey, thick-bedded, highly recrystallized, rare and poorly preserved bioclastic (dasyclad algae and ostracod) pseudomicritic limestones. Dissocladella cf. savitriae and Dissocladella sp. are identifiable dasyclad algae, which indicate that the age of the neritic part of the carbonate succession is not older than the Maastrichtian. Neritic limestones are abruptly and conformably overlain by 16 m-thick maroonish grey, distinct, thin to medium-bedded planktonic foraminifera- and calcisphere-bearing, indurated micritic limestones (7.4 m-thick level-3 and 8.6 m-thick level-4). The micritic limestones represented by wackestone/carbonate mudstone texture locally include calciclastic limestone (grainstone/packstone texture) interlayers. Abundance of planktonic foraminifera increases upward in the section in this pelagic level, where diversified planktonic foraminiferal assemblages are observed (in level-4). Many species belonging to the genus Abathomphalus, Contusotruncana, Globotruncana and Globotruncanita were determined in thin sections of the samples. Presence of A. mayaroensis within the assemblages of the first bed of the pelagic limestones shows that the age of the pelagic succession is late Maastrichtian. Moreover, the species C. contusa, Gt. conica and Racemiguembelina fructicosa, which are commonly observed within the pelagic upper Maastrichtian deposits, are determined in various stratigraphic levels of the sequence as well. This level is overlain by 6.6-m-thick rare Paleocene planktonic foraminifera-bearing laminated micritic limestones (level-5). A thin (5 to 13 cm-thick) conglomerate bed is observed at the Maastrichtian-Paleocene boundary. Sandstone-mudstone alternation lies at the top of the succession (level-6). The obtained stratigraphic and paleontologic data from the uppermost Cretaceous-Paleocene carbonate succession of the Spil Mountain suggest that the onset of pelagic deposition in that area occurred during the late Maastrichtian and continued during the Paleocene. If this sequence belongs to the Bornova Flysch Zone platform, it indicates that the southwestern part of the Zone started to collapse in Maastrichtian.

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Keywords: planktonic foraminifera; dasyclad algae; biostratigraphy; carbonate platform drowning; Spil Mountain; Bornova Flysch Zone
New foraminiferal ages and facies depictions from the Mesozoic carbonate blocks between Menderes and Gümüldür (İzmir, western Anatolia): comparison with nearby carbonate sequences

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The Mesozoic carbonate successions, cropping out around Menderes and Gümüldür, are represented by neritic limestones, dolomitic limestones and dolostones belonging to different blocks or slices of the Bornova Flysch Zone. Limestone and dolomitic limestone parts of sections consist of biomicritic, biosparitic limestones and Thaumatoporella-bearing biolitites. Some blocks comprise Upper Triassic to Lower Jurassic carbonates and some others include only Lower Jurassic limestones.

Triassic part of these carbonate sequences includes a foraminiferal fauna consisting of Aulotortus gr. sinuosus, Aulotortus sp., Reophax sp., Trochammina sp., Textularia sp., Endotriada sp., Ophthalmidium sp., which allow us to attribute a Late Triassic age. Jurassic part of the sections, on the other hand, has a foraminiferal fauna consisting of Siphovalvulina cf. gibralterensis, Lituosepta sp., Duotaxis metula, Meandrovoluta asiagoensis, Duotaxis sp., Trocholina sp., Endotriadella sp., Pseudocyclammina sp., Orbitopsella praecursor, Agerina cf. martana and indicates a Liassic age.

The Triassic and Liassic neritic carbonate sequences of the Menderes-Gümüldür area are similar with those of Karaburun Peninsula, Urla, Kaynaklar (Buca), Eğridere (Bornova), East Akhisar (Manisa) and Emet (Kütahya) in terms of facies, depositional environment and characteristics of foraminiferal fauna. However, they are different from the Keçili (Manisa), Akhisar (Manisa), Kurkağac (Manisa) and Soma (Manisa) carbonate successions, Liassic beds of which are made up of pelagic limestones. Thus the Menderes-Gümüldür carbonates should be deposited in the same paleogeographic zone with the Karaburun-Emet sequences.

Keywords: Late Triassic; Liassic; Jurassic; western Anatolia; carbonate successions
Late Cenomanian-?late Turonian planktonic foraminiferal biostratigraphy of a pelagic Tavas Nappe succession from the Kızılca area (Tavas, Denizli) of the Lycian nappes (SW Turkey): preliminary results

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Keywords: Planktonic foraminifera; Cenomanian-Turonian boundary; biostratigraphy; Tavas Nappe, Lycian nappes

The Upper Cretaceous pelagic limestones (Bahadağ Formation) in the Kızılca area (Tavas, Denizli-SW Turkey) belong to the Tavas Nappe of the Lycian nappes. A 14.5m-thick stratigraphic section was measured from the pelagic limestones and 35 samples were systematically collected through this section in order to document planktonic foraminiferal biostratigraphy of the succession. The pinkish to beige pelagic micritic limestones, which are mainly represented by rich planktonic foraminifera-bearing wackestone depositional texture are interbedded with thin (a few cm to 50-60 cm) to thick (more than 2 m) light gray calcarenite beds. The calcarenite beds comprise rich canaliculate rudist fragments and orbitolinid foraminifers and are represented by grainstone/rudstone depositional texture. The calcarenite beds are indicative of proximity to shallow water environment. Some of the calcarenite beds are slumped. The lower 4 m-thick (samples 1 to 9) part of the succession comprises rotaliporids such as *Rotalipora*, *Thalmanninella* and *Pseudothalmanninella* suggesting a late Cenomanian age. First *Helvetoglobotruncana helvetica*, nominate taxon of the early to middle Turonian *H. helvetica* Range Zone appears in a bed (in sample 10) 30 cm above the last occurrence of the rotaliporids (in sample 9). Diversified assemblages comprising species of the genus *Marginotruncanida*, *Dicarinella*, *Praeglobotruncanida* and *Whiteinella* accompany *H. helvetica*. The 30 cm-thick interval is represented by a planktonic foraminiferal turnover and corresponds to the Cenomanian-Turonian boundary interval. Single-keeled marginotruncanids such as *M. sigali* dominate the assemblages in the beds between samples 15 to 17. The last occurrence of *H. helvetica* in sample 19 indicates that the thickness of the *H. helvetica* Zone in the Kızılca succession is 4.4 m. Double-keeled marginotruncanids such as *M. paraconcavata*, *M. tarfayaensis*, *M. coronata* etc. dominates the assemblage at the upper part of the succession (sample 25 and above). Preliminary studies based on the planktonic foraminiferal assemblages from the 14.5 m-thick Kızılca section show that the assemblages are dominated by k-selected specialists of more oligotrophic environment. The assemblages indicate that the age of this part of the succession is late Cenomanian-?late Turonian. This stratigraphic interval encompasses the Cenomanian-Turonian boundary interval, where a global oceanic anoxic event (OAE-2) occurred.

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Palaeoenvironmental evolution of the Eocene Marine Evaporite bearing units in the Western Pontides (Karabük area of NW Turkey): Palynoflora, Foraminifers, Nannoplanktons and Clay mineralogy

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Karabük Paleogene basin is developed as intermontane in the north of the Izmir-Ankara-Erzincan suture zone, due to the N-S directional compressional regime on the Intra Pontide Belt that is located in the passage between Sakarya Zone and Istanbul Zone. The Eocene-Oligocene units forming the basin fill are angularly unconformable on older basement rocks. These units in the Karabük area is represented by the Safranbolu formation containing ramp type carbonate deposits, delta-turbidite association siliciclastic sediments of the Karabük formation, meandering alluvial deposits of the Çerçen Member, banks type carbonates of the Soğanlı formation, various gypsum facies evaporitic of the Pürçükören formation, and carbonate-mudstones of the Akçapınar formation produced by closed/restricted basin, respectively.

In this study, samples collected from the claystones, and mudstones within the evaporitic sediments of the Safranbolu, Karabük, Soğanlı, Pürçükören and Akçapınar formations in the Karabük area are studied palynologically. Besides, foraminifer fauna of the Safranbolu, Karabük, and Soğanlı formations and nannoplankton fauna of the Karabük formation are defined. The mangrove forests characterized by Pelliciera rhizophorae, Köpek pollenites transdanubicus, Diporopollis iszkaszentgyorgyi, K. magnus, Avicennia marina, Spinizonocolpites echinatus (Nypa) are firstly recorded in Anatolian Early Eocene (Kuvizian) sediments. The recorded abundance of these forest elements declines throughout Eocene in the deposition of these formations in Karabük area, but the percentage of the plants growing in the mangrove environment (back mangrove elements: e.g. Tilioideae-Brownlowioideae, Araliaceae-Aralia, Simaroubaceae-Suriana, Acrostichum aureum, Reveesia and Proxapertites (Araceae)) increases. The terrestrial condition is dominated at the Late Eocene of the Karabük area during deposition of the Akçapınar formation based on the widespread terrestrial palaeovegetation groups (e.g. lowland, riparian, swamp, montane forests).

During the Early-Middle Eocene, the tropical climate was observed in areas close to the coastline where mangrove forest grows, whereas the subtropical climate could be occurred towards the land. From the Middle to Late Eocene, a marked drought (MAP 1391-673mm) is observed with cooling in palaeoclimatic conditions in the Karabük area. Besides, this palaeoclimatic and palaeoenvironmental evolution of the Karabük area during the Eocene could have been affected by the tectonics and regional palaeoclimatic conditions.

Thanks to TUBITAK-CAYDAG 116Y140 numbered project.

Keywords: palynology; foraminifers; nannoplanktons; eocene; mangrove; karabük
Primary palynological and palaeovegetational data of the Middle-Late Eocene sediments of the Yozgat province in the Central Anatolia

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Çankırı-Çorum Basin in the Central Anatolia is located between the Kırşehir and Sakarya continents, and it was a collisional basin among these continents during the Palaeogene. Basement rocks are consisted of the continental and shallow marine sediments and overlaid by the Late Cretaceous Kırşehir Block unconformably. The Middle-Late Eocene Yoncalı Formation comprised of marine shales, claystones, mudstones with rich organic material, mollusca, foraminifera and ostracoda fossils, sandstones and limestone lenses are unconformably overlaid the basement unit.

In this study, coal-bearing sediments in Yozgat-Çiçekdağ and Arabınmahallesi of the southern part in the Çankırı-Çorum basin are studied. Totally 158 coal, claystone and mudstone samples are collected from the drill of southeastern of the Çiçekdağ coal mine, center of the coal mine and stratigraphic section of Arabınmahallesi. The Middle-Late Eocene palynoflora of the Yoncalı Formation is characterized by more abundant and diverse fern spores (Lygodiaceae-Lygodium: Leiotriletes spp., Corrugatisporites spp., Pteridaceae-Pteris: Polypodiaceoisporites spp., Selaginellaceae; Echinatisporis spp., Muerrigerisporis sp., Osmundaceae: Baculatisporites sp., Trilobosporites sp., Ischyosporites sp. and Verrutriletes sp.) and bryophyta spores (Sphagnum: Stereisporites sp.). The conifers are less common in the Yoncalı palynoflora, (Pinaceae-Pinus diploxylon and haploxylon types) and Cathayapollis sp. Angiosperm pollen species are represented by e.g. Arecaceae-Palmae and Nypa, Arecaceae-Phoenix palm, Castanea, Juglandaceae-Engelhardia, Plicapollis sp. and Sapotaceae. Dinoflagellate cysts and some fragments, which could not be identified, play an important role in the quantitative composition of some samples of drill in the southeastern Çiçekdağ coal mine.

Presence of pteridophyte/bryophyte fern spores and palm pollen species indicates a dominant humidity in palaeoclimate during the deposition of Yoncalı Formation. The gymnosperm pollen species characterized by Pinaceae-Pinus diploxylon and haploxylon types and Cathaya considered an important member of mid-highland area forest. Besides, the assemblage indicates climatic condition between warm-subtropical and tropical during the Middle-Late Eocene in Yozgat. According to the existence of dinoflagellate cysts, marine influence is effected during the deposition in that time of the Yoncalı Formation.

Keywords: Middle-Late Eocene; palynology; palaevegetation; Eastern Anatolian; Yozgat
Scientific Session A.3
Magmatic Geodynamics & Volcanology in the Mediterranean Region

Conveners:
Dr. Dejan PRELEVIĆ; Dr. Michele LUSTRINO; Dr. Erkan AYDAR;
Dr. Cüneyt AKAL; Dr. Altuğ HASOZBEK
Origin of lime-rich San Venanzo Pleistocene volcanic rocks (central Italy). Source characteristics or effects of shallow carbonate interaction?

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San Venanzo is a small Pleistocene (~590-265 ka) volcanic complex consisting of three small eruptive centres: San Venanzo maar, Pian di Celle tuff ring with small lava flows and Celli lapilli ring. It belongs to the so-called ULUD (Umbria-Latium Ultra-alkaline District), grouping volumetrically insignificant, but petrologically relevant monogenetic volcanoes and other outcrops of doubtful magmatic origin scattered along the Apennine Mts. Axis in central Italy (Colle Fabbri, Polino, Cupaello, Grotta del Cervo and Oricola-Camerata Nuova). San Venanzo products, such as many ULUD volcanic and pyroclastic rocks are strongly SiO2-undersaturated, CaO- and MgO-rich and show mostly potassic to ultrapotassic serial character. A peculiarity of ULUD rocks is the relatively common occurrence of calcite, interpreted as primary mineral, hence postulating the presence of a diffuse carbonatitic component.

The three eruptive centres pierced a substrate mostly represented by Miocene marls, marly limestones and sandstones, lithologies commonly found as xenoliths and lithic fragments. The main rock types are melilititic, kalsilite-bearing (i.e., kamafugitic) lava flows, also with a pegmatoid variant (melilitolitic pocket), and variably calcite-enriched scoria and lapilli tuffs. All the San Venanzo volcano samples are plagioclase-free and their petrography is characterized, in different proportions and not necessarily simultaneously present, by forsteritic olivine, diopside, melilite, leucite, kalsilite, opaque minerals ± nepheline, phlogopite, calcite, apatite, cuspidine and glass. On the basis of petrographic analyses, the studied rocks can be classified as olivine melilites, olivine leucite melilites, venanzites, melilitolites and Ca-rich olivine leucite melilitite tuffs. Primitive mantle-normalized patterns of the lavas and tuffs are rather spiked and share negative anomalies for Ba, Nb, Ta, P and Ti. The melilitolite sample is generally more enriched in all the incompatible elements, compared to the other San Venanzo rocks. Major and trace element content indicate a general depletion proportional to the amount of carbonate (exemplified by the CaO content) in all the San Venanzo rocks. The observed trends in Harker-type diagrams are compatible with a process of variable interaction between a silicatic magma and a sedimentary carbonate. The presence of Mg-rich (Fo₉₇₋₉₂) and rim-ward CaO increase (up to 1.72 wt. %) euhedral olivine, agree with a process of assimilation of crustal carbonates by an already strongly SiO₂-undersaturated silicatic magma. The lack of plagioclase even in the rocks with the highest SiO₂, the high CaO content, and the extreme SiO₂-undersaturation of San Venanzo products exclude their derivation from a simple peridotitic source. In order to generate these peculiar compositions, the presence of a SiO₂-K₂O-CaO-rich component, identified in a metasomatic source (carbonated phlogopite peridotite) is essential.

In addition, mass balance calculations indicate a direct genetic link between the lava body and pegmatoid melilitolitic pocket through a fractional crystallization process characterized by the removal of ~64% of a melilitite-bearing udangitic cumulate made up of olivine, clinopyroxene, melilite, leucite and chromite.

Keywords: kamafugite; ultrapotassic; Pleistocene; carbonatite; limestone; Italy
The pyroclastic breccia of Cabezo Negro de Tallante (SE Spain): first finding of carbonatite magma in the internal domains of the Betic Cordillera

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We have investigated the carbonate-rich pyroclastic deposit interbedded in between a phreatomagmatic breccia and a thin lava flow at the Cabezo Negro de Tallante (CNT), a well known Pleistocene volcano characterized by the presence of abundant mantle and crustal xenoliths. Together with a thin, hardened crust formed by carbonate remobilised during surface weathering interpreted in literature as a caliche, on the basis of petrographic, mineralogical, isotopic and field evidences we claim the existence of a mantle carbonate component.

The matrix of the CNT carbonatitic pyroclastic breccia contains carbonate and silicate liquids and solids. The presence of carbonate in the middle pyroclastic breccia and the associated mantle xenoliths argues against precipitation from hydrothermal and/or ground water. Carbonate vein network and/or alteration in the associated lava flows and lithic clasts population are completely absent in the investigated portion of the outcrop ruling out a secondary origin for the carbonate component. Moreover, the presence of sharp, curved menisci between the carbonate and silicate liquids and the presence of globules of carbonate in silicate glass and vice-versa, are here interpreted as evidence of the separation of the two magmatic compositions and strongly support liquid immiscibility. The presence of rounded relics of dolomite crystals, enveloped by micro-vesicular dolomitic glass surrounded by Mg-calcitic glass, supports a complex and fast evolution of the magmatic system. The presence of carbonate globules in fresh silicate melt inclusions within mantle xenolith crystals, as well as droplets of silicate glasses enclosing carbonate globules and phenocrysts, precludes a secondary origin for the carbonate. The occurrence of bimodal carbonate mineralogy, consisting of either calcium carbonate and dolomite, and the observed transition from dolomitic melt to Mg-calcitic melt, well agree with a magmatic origin.

Dolomite relics indicate that magma sources were located ~60-70 km deep, in a dolomite-bearing lherzolitic mantle. The system reached the solidus, triggering the melting and production of the dolomitic melt. Successively, the upwelling magma crossed the carbonate ledge reacting with the silicate portion, leading to the transformation of dolomitic melt into Mg-calcitic melt + CO₂ (micro-vesicles). The expansion of the CO₂ vapour quenched the magmas during the upwelling, preserving the observed features. The coexistence of silicate and carbonate liquids suggests a liquid immiscibility after melting. Such a process can lead to two extreme liquids from average hybrid compositions, leading to the formation of nearly pure carbonatitic melt and a CaO- and CO₂-poor SiO₂-enriched liquid, able to crystallize plagioclase. Such a process of liquid immiscibility is extremely rare in basaltic lithologies, while it is common in ultrabasic (e.g., nephelinitic to melilititic) or intermediate/acid (e.g., phonolitic and trachytic/syenitic) compositions.

Our conclusions open new eruptive scenarios associated with the Plio-Pleistocene alkaline volcanism of the Betic cordillera, and suggest to assess with more accuracy the meaning of carbonatitic magmas in the SE Spain. We suggest that the combination of field and petrographic features, as well as chemical considerations on minerals and whole rocks, are compatible with a primary and magmatic origin of the carbonate in the Cabezo Negro de Tallante pyroclastic breccia.

Keywords: carbonatite; basalt; immiscibility; Betics
Age and geochemical constraints on petrogenesis of the Zajkan granitoid, Tarom-Hashtjin magmatic belt, NW Iran

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The Alborz Range, ~600 km long and 100 km width, in northern Iran is part of the central segment of the Alpine-Himalayan belt and is situated between the Caspian Sea to the north and the Iranian Plateau to the south. It extends westwards into the Lesser Caucasus in Armenia. The Tarom-Hashtjin magmatic belt (THMB) is the western part of the Alborz range. The tectonic evolution of the THMB is associated with Cenozoic closures of Neo-Tethyan Ocean and related micro-continental collisions, as well as later post-orogenic events. Magmatism in the THMB began during the Eocene and continued through the late Eocene and continued through the late Eocene and early Oligocene.

The Zajkan granitoid is located at the southeastern end of the THMB, northwest of Qazvin. This intrusion was intruded into the Eocene volcanic and volcaniclastic rocks. It shows a close spatial relationship with the epithermal mineralization systems. The Zajkan granitoid mineralogically composed of pyroxene quartz monzodiorite, quartz monzonite, and granodiorite. LA-ICP-MS zircon U–Pb dating indicates that the Zajkan granitoid crystallized in ca. 36.5 Ma. Geochemical data indicate high-K calc-alkaline to shoshonitic, metaluminous compositions and an I-type granite affinity. The ⁸⁷Sr/⁸⁶Sr and ¹⁴³Nd/¹⁴⁴Nd ratios are 0.7035–0.7053 and 0.5126–0.5130, respectively, and εNd(T) values range from −0.22 to 6.49.

The Zajkan granitoid is characterized by coherent chondrite-normalized REE patterns with a high LREE/HREE ratio and negative Eu anomaly. On primitive mantle-normalized spider diagram, it has negative HFSE anomalies, LILEs enrichment, and positive Pb anomaly, indicating a subduction-related signature. Tectonic setting discrimination diagrams of granitoid rocks indicates post-collisional setting for the Zajkan granitoid.

Keywords: Granitoid, Zajkan; Tarom-Hashtjin
The Post-Collisional Sarımehmet basalts: Whole rock K-Ar geochronology, geochemical, Sr–Nd isotopic and magma source characteristics, Eastern Anatolia, Turkey

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The area which is located east of Karlıova triple junction is called East Anatolian Accretionary Complex (EAAC). The Sarımehmet basalts that are located in EAAC are about 45km northeastern of the Van province. Whole-rock K–Ar data refer that these basaltic lavas erupted between 3.81Ma and 4.66Ma (Zanclean–Pliocene). These rocks have ophitic, glomeroporphyritic and trachytic textures and mainly consist of plagioclase, clinopyroxene and olivine minerals. SiO$_2$ contents of these rocks vary between 48.09 and 50%wt. The Sarımehmet basalts exhibit enrichment in LILEs and LREEs and depletion HFSEs and HREEs. A negative correlation between SiO$_2$ and $\varepsilon$Nd(t) and a positive correlation between SiO2 and initial $^{87}$Sr/$^{86}$Sr$_{(i)}$ ratios suggest that the Sarımehmet basaltic rocks have been contaminated by continental crustal materials during magma emplacement. The EC-AFC model indicates that the last products of the Sarımehmet basaltic lavas could have been contaminated by the upper continental crust materials which ratio between ~2.6 and 3.2%. The model prepared using (Gd/Yb)N and (La/Yb)N indicate the first products of the basaltic lavas were formed by ~2.5–4% partial melting of spinel bearing lherzolitic source. All data suggest that the Sarımehmet basalts were derived from the partial melting of metasomatised lithospheric mantle source and reached to the surface from the fissures which are developed by the effect of the extensional tectonics in the region.

Keywords: Van; Pliocene; Basalt; Fissure eruption; Crustal contamination; Eastern Anatolia
In-situ crystallization of a small scale gabbroic body: the Yıldızdağ Gabbroic Intrusion (northern, Turkey).

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The Yıldızdağ Gabbroic Intrusion (YGI) represents a rare snapshot of an exposed mafic magma reservoir of the middle Eocene age in northern Turkey. The YGI intruded into early Cenozoic sand-shale alternations of the Izmir-Ankara-Erzincan suture zone. The main driving mechanism of middle Eocene magmatism is the delamination of the lithospheric mantle in post-collisional times after the suturing stages or slab-break off the relict Tethyan oceanic slab.

YGI is represented by sub-horizontal intrusive units that are exposed at the summit in the Yıldızdağ Mountain and covers a surface area of ~2.5 km². There are mainly four different rock units identified in the intrusive body. At the bottom, a lower olivine gabbro is exposed and marks the most common lithology of the intrusion. Around the top, an upper olivine gabbro forms the summit of the mountain. Both lower and upper olivine gabros contain troctolitic enclaves that display oblate and lobate shapes (<50 cm in diameter). Finally, a hornblende gabbro is mainly exposed around the eastern portion of the intrusion, discordant to the olivine gabros. Different units within the YGI display mainly diffuse/gradual and rarely sharp contacts with each other and indicate high temperatures conditions during the amalgamation of the different rock types. Late-stage monzodioritic to dioritic dykes cut both the YGI and sandstone-shale alternation with sharp contacts.

The YGI characterized by the presence of cumulus (high Mg# pyroxene + high An plagioclase ± olivine) and intercumulus phases (low Mg# pyroxene ± low An plagioclase ± brown and green amphibole ± Fe-Ti oxides ± apatite ± quartz). Gabbroic units are fresh and mostly devoid of alteration and intercumulus phases such as green hornblende-biotite-quartz have a magmatic origin. All mineral phases display normal zoning from higher An (plagioclase) and Mg# values (clinopyroxene) to lower values from the core to rim. With the exception of the troctolites, the peritectic reaction of clinopyroxene + liquid to amphibole is recorded in all lithologies. Trace element measurements of individual clinopyroxenes from lower olivine, upper olivine and hornblende gabbro series display up to a 10 fold increase from the core to rim in rare earth elements. These characteristics imply that the YGI mainly formed by in-situ fractionation of a hydrous magma with trapped intercumulus liquid.

Calculations based on the equilibrium distribution method show that between 10 and 12% interstitial trapped liquid have been present within the lower and upper olivine gabbro units. Thus, closed system in-situ fractional crystallization modeling also successfully reproduce the core-mid zone and rim compositions of the clinopyroxene, which is consistent with minimal assimilation with the surrounding country rocks without any prominent magma mixing. ⁸⁷Sr/⁸⁶Sr (0.704438 – 0.704864) and ¹⁴³Nd/¹⁴⁴Nd (0.512750 – 0.512824) isotopic data display limited variation and supports the interpretation of limited assimilation.

The data presented above indicate that the YGI represents a small intrusion that efficiently trapped a significant amount of interstitial liquid and evolved during in-situ fractionation with limited interaction with surrounding rocks.

Keywords: petrology; Yıldızdağ Gabbroic Intrusion; in-situ fractionation; mineral chemistry
Pristine vs. metasematized mantle source of Cenozoic Anatolian magmatism: insights from boron and radiogenic isotopes

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Combined B and radiogenic (Sr-Nd-Pb) isotope study has been carried out in 33 samples representative of Cenozoic magmatism occurring from the Cappadocia region to South-East Anatolia. These samples, combined with those from Aegean-West Anatolia (Tonarini et al., 2005; Agostini et al., 2007) allowed some insight on the characters of mantle sources of Cenozoic Anatolian magmatism, from its western end to its south-eastern sector. Alkaline basalts with typical intraplate type affinity are found in Western Anatolia (Biga Peninsula and Kula), Central Anatolia (Cappadocia), Central-Eastern Anatolia (Arguvan), Eastern Anatolia (Elazığ and Karakoçan), all resting on the Anatolian Plate, and in South East Anatolia, both along the northern termination of the Dead Sea Fault Zone (Osmaniye and Karasu) dividing the Arabian and African plate, or on the Arabian Plate foreland (Gaziantep and Karacadag). These basalts have δ¹¹B varying from -1.3 to -7.6‰, with a good negative correlation with ⁸⁷Sr/⁸⁶Sr (0.7030-0.7037), revealing the occurrence of a sublitospheric mantle with some small-scale heterogeneity, with large overlaps between Anatolian and Arabian plate. Other alkaline basalts, both with Na or K affinity, reveal the occurrence of some interactions with subduction-related fluids, retaining higher ⁸⁷Sr/⁸⁶Sr and lower δ¹¹B values.

Cenozoic orogenic rocks found in Anatolia exhibit a greater variation both for Nd, Sr and B isotopes, with values of δ¹¹B <0 ‰ and as low as -12 ‰ for calc-alkaline samples and -16‰ for the ultra-K rocks of Western Anatolia. It is noteworthy that no significant differences are found among the samples erupted in a post-collisional context (e.g. Western Anatolia, Cappadocia) and those belonging to a typical arc magmatism activity, with active subduction, such as those from Yamadağ and Kepez Dağ in Central-Eastern Anatolia and Mazgirt-Pertek in Eastern Anatolia. As a whole, the negative δ¹¹B values of these lavas suggest that subduction-related fluids of the subducting African slab throughout the whole Anatolian region are dominated by continental sediments, whereas extremely negative values for some samples (e.g. ultra-K rocks of Western Anatolia) are indicative of the occurrence of residual fluids in a dehydrating slab.

Keywords: Cenozoic volcanism; Anatolia; boron isotopes

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Miocene to Pliocene activity in Sivas-Malatya region, Central-Eastern Anatolia: time shift from subduction- to strike slip-related volcanism.

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In the Central-Eastern Anatolia, abundant orogenic magmatism resulted from the convergence of the Arabian plate towards the Eurasian one, which finally collided and sutured along the Bitlis Zagros Suture Zone (Late Eocene-Early Miocene). After the collision, scattered intraplate-type basaltic volcanism developed along transtensional strike-slip faults, linked with the North Anatolian Fault Zone, the East Anatolian Fault Zone, and Central Anatolian Fault Zone.

In the study area, located in between the Kızılirmak and Malatya-Ovacık strike-slip faults, both calc-alkaline and alkaline rocks occur. Calc-alkaline volcanic activity developed during the Early to Middle Miocene, with the Yamadağ (18.7-13.6 Ma) and Kepez Dağ (15.9-14.1 Ma) Volcanic Complexes, which were characterised by basaltic to rhyolitic volcanic rocks. These rocks bear the typical geochemical and isotopic characteristics of subduction-related magmas: i.e., Large Ion Lithophile Elements enrichments, High Field Strength Elements depletions, with strong Nb-Ta negative anomalies, high 87Sr/86Sr (0.70396-0.70539) and low 143Nd/144Nd (0.51260-0.51287).

Coeval Early-Middle Miocene (16.5-13.1 Ma) basaltic plateau lavas were emplaced in Sivas along the Kızılirmak strike-slip fault. These rocks are Na-alkaline basanites and alkali-basalts, showing, in spite of their alkaline character, high LILE/HFSE ratios, and 87Sr/86Sr (0.70414-0.70553) and 143Nd/144Nd (0.51261-0.51282) isotopic composition close to those of calc-alkaline volcanic rocks. These characteristics strongly suggest the persistence of a relict subduction-related geochemical signature in the mantle source of Na-Alkaline intra-plate magmas of Sivas volcanic field.

Alkaline basaltic volcanic rocks from Arguvan-Arapgir erupted as less small linear lava flows aligned along the Malatya-Ovacık strike slip fault in the Late Miocene (~10 Ma). They range from alkaline basalts to mugearites, and are characterised by humped patterns of the incompatible element diagrams, typical of intra-plate volcanic rocks. The lower 87Sr/86Sr (0.70347-0.70384) and higher 143Nd/144Nd (0.51277-0.51291) with respect to calc-alkaline rocks suggests the involvement of a sub-lithospheric mantle source, even if some enrichment in fluid-mobile elements display that also the Arguvan- Arapgir mantle source was affected by a previous subduction event.

During the latest Miocene to Pliocene (5.9-4.0 Ma), scattered basaltic lava flows erupted within the Kangal basin. These rocks are K-alkaline basalts to shoshonites, show LILE enrichments and Nb, Ta, and Ti depletions. Higher 87Sr/86Sr (0.70425-0.70520) and lower 143Nd/144Nd (0.51262-0.51277) ratios with respect to Arguvan- Arapgir basalts suggest that a crustal component is involved in their genesis. In this case, crustal contamination en-route to the surface rather than recycling in the mantle source is proposed, on the basis of petrographic characteristics and numerical modeling.

The transition from calc-alkaline to Na-alkaline volcanic rocks is related to the geodynamic evolution of the region. Early-Middle Miocene orogenic represent the arc volcanism linked with active subduction of oceanic slab of African Plate, whereas alkaline magmas from Sivas, Arguvan- Arapgir, and Kangal, mark the shift from compressional to strike slip tectonic regime, with the development the Kızılirmak fault and the Malatya-Ovacık fault zone. The crustal signature in the youngest activity of the Kangal is ascribed to crustal contamination rather than a renewal of subduction components in the mantle source.

**Keywords:** Sivas-Malatya; radiogenic isotopes; geochronology
Debate on the presence of transitional rock association in post-collisional setting - examples from Carpathian – Pannonian Region and Anatolia

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Volcanic rocks in orogenic, subduction-related setting may be subdivided in two major series, alkaline and subalkaline, separated by a line in the SiO₂ vs. Na₂O+K₂O diagram, as proposed by many authors since late 19th century (e.g. Wilson, 1989 and references therein) up to early 2000th when several authors (LeBas et al, 1986; Le Maitre et al., 1989, 2002) applied IUGS recommendations that are used up to now by most the petrologists, known as TAS diagram. It was recognized that the boundary between alkaline and subalkaline, even marked by a solid line, is gradational, however, rocks that are plotting in this transition have not a specific name, each of the magma series ranging with different terminology from basic to acid. Only by using Na₂O vs. K₂O diagram was it possible to discriminate between primitive Na-series and K- and high-K-series a field named “transitional” (Middlemost, 1975; Le Maitre et al., 2002). Recently there was an attempt to distinguish the so-called “transitional basalts”, by using different boundary lines in the total alkali-silica diagram (El-Hinnawi, 2016). Transitional rock association have been found in all the tectonic settings (e.g., Wilson, 1989 and references therein) and recently discussed also using trace elements and isotopes in rock association related to post-collisional setting in Carpathian-Pannonian region and western Anatolia (Seghedi et al., 2013); it was found that transitional rock association is time-dependent and signifies a shift from the lithosphere orogenic (subalkaline magmas) to asthenosphere anorogenic (Na-alkalic magmas) reservoirs, though with periods of interruptions. Here we wish to debate if transitional rock association occurs also in the central and eastern Anatolia in order to better understand the spatial evolution of the magma reservoirs and the geodynamic processes at the mantle and crustal levels.

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Keywords: transitional rocks; post-collisional; geodynamic processes

References:
We present here detailed petrography, new mineral chemistry data, and geothermobarometry calculations in order to provide constraints for the emplacement conditions of the Gürgenyayla pluton (GP) which is a representative product of Eocene magmatism in NW Anatolia. The GP was intruded into the İzmir-Ankara-Erzincan Suture Zone (IAESZ) and is mainly granodiorite in composition with holocrystalline granular-to-porphyritic texture. It consists of 35–40% plagioclase, 25–28% quartz, 20–25% K-feldspar, 5–10% biotite, and 4–10% hornblende. According to the results of mineral chemistry analyses, the amphiboles in the GP are represented by magnesiohornblende, and plagioclases display Oligoclase (An17-29) and Andesine (An30-48) compositions. Amphibole-plagioclase geothermobarometry calculations yielded an average pressure of 1.4 kbar and an average temperature of 769°C, which corresponds to approximately 4.8 km depth of emplacement for the GP. The integrated studies on petrography, mineral chemistry and geothermobarometry calculations show that Gürgenyayla pluton, similar to the adjacent Topuk pluton, is a shallow level intrusion which was emplaced into the upper crust.

Keywords: NW Anatolia; Eocene; Gürgenyayla; mineral chemistry; geothermobarometry
New U-Pb zircon ages from the Miocene volcanic association around İzmir: What they state for evolution of the terrestrial Miocene basins in western Anatolia?

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The bimodal, high-K calc-alkaline to weakly alkaline Miocene volcanic association crops out widely around İzmir in western Anatolia. From Aliağ, in the north, to Cumaovas, in the south, basaltic to rhyolitic lavas and pyroclastic rocks interdigitate with the Miocene fluvial to lacustrine sedimentary succession. This volcano-sedimentary complex unconformably overlies the Pre-Neogene basement along a basal conglomerate horizon. The sedimentary units pass gradually upward into sandstones, siltstones, claystones and end with widely exposed clayey limestones and limestones. The lacustrine limestones at the top, in places, overlap directly the basement units. The lowermost layers of the sequence and nearshore facies are dominated by conglomerates and sandstones of different ages. Middle-upper parts and offshore facies, on the other hand, are dominated by mudrocks and limestones.

From the oldest part of the sedimentary basin, between İzmir and Manisa, a Burdigalian-Langian (20.44-13.82 Ma) palynomorph assemblage is determined. The oldest volcanic entry, around İzmir, into this sedimentary succession is weakly alkaline Beşyol basaltic lava flows that are found above the coal-bearing claystone levels. Zircons from the Beşyol basalt yield an 18.1 ± 1.1 Ma eruption age (ICP MS-LA). The Miocene volcanism attains andesitic character in upper parts. From the syn-depositional andesite lavas in İzmir (Bornova, Koçaçay valley), 18.84 ± 0.19 to 17.36 ± 0.20 Ma U-Pb zircon ages (ICP MS-LA) are obtained. Northward, the lateral continuation of this volcanism starts with andesites yielding 17.12 ± 0.22 to 16.45 ± 0.49 Ma zircon ages (SIMS) and pass upward into the rhyolites of 16.74 ± 0.41 to 15.2 ± 0.37 Ma (SIMS, U-Pb zircon). The younger volcanic units interdigitating with the Miocene sedimentary succession are the rhyolitic tuffs in Buca (İzmir) which are dated as 13.73 ± 0.15 Ma, weakly alkaline basaltic lavas and dykes in Foça which are dated as 12.97 ± 0.26 Ma (SIMS, U-Pb zircon) and rhyolite domes in Cumaovası (İzmir) which are dated as 12.43 ± 0.53 Ma (ICP MS-LA). The youngest age obtained from the volcanic suite around İzmir is from a rhyolite dome in Cumaovası region which is dated as 10.73 ± 0.33 Ma (ICP MS-LA). This entire Miocene volcanic activity was controlled by N-NE-trending tectonic lines which, in places, control the geometry of sedimentary basins and cut the basin fill as well.

New radiogenic age data obtained from a large area in western Anatolia and lateral relationships between the volcanic rocks and sedimentary successions indicate that (i) the Miocene volcanism, around İzmir, is basalt to rhyolite in composition and accompanies the sedimentary deposition from Early to Middle Miocene, (ii) contrary to the previously suggested models, the Miocene sedimentation and volcanic activity formed uninterrupted sections that indicate there was no such a change in the tectonic regime during the Miocene basin evolution, and (iii) today’s separately-defined Miocene basins are parts of a regional-scale compression-related basin that covered already uplifted and emerged Anatolian block. This Miocene basin developed above a progressive collision zone between Gondwana and Sakarya Block and is named here for the first time as the Western Anatolian Inter Arc Basin (WAIAB).

Keywords: Neogene; Miocene basin; Western Anatolian Inter Arc Basin; İzmir; U-Pb zircon ages; palynology
Central Anatolia (Turkey) constitutes a high plateau elevation which hosts a continental volcanic province with eruptions of Miocene to Upper Holocene age, the Central Anatolian Volcanic Province (CAVP). The province is composed of several large polygenetic volcanic edifices and numerous monogenetic volcanic centers of Quaternary age. The monogenetic centers are gathered within six clusters oriented from SW to NE. The spatial distribution of these volcanic systems provides a perfect environment to investigate the volcano-tectonic interactions involved in the generation of large monogenetic volcanic clusters, and controlling the spatial distribution of monogenetic volcanic vents. In this study, we focus our analyses on the morphological characteristics, self-similar clustering and volcanic alignment analysis of Quaternary monogenetic vents within the CAVP.

We identify a total of 555 monogenetic vents and classify them in terms of morphology (~238 scoria cones, ~165 lava domes, and ~20 maars) using satellite images, topographic maps and fieldwork. The CAVP displays almost all types of scoria cones (e.g. gully, horseshoe, tilted, crater row), lava domes (e.g. spiny, lobate) and maars (e.g. coalescent and nested craters). The morphological analysis of scoria cones reveals that the median width and height are 620 m and 61 m, respectively. Most of them possess a crater at their summit with the median width and height of 206 m and 18 m, respectively. The median width and height of lava domes are 813 m and 134 m, respectively. The empirically calculated cone slopes range from 7° to 32°, whereas those calculated on digital elevation models range from 5° to 26°. The total maximum volume of the scoria cones is $5.2 \times 10^9$ m$^3$.

Monogenetic vents in each cluster show a self-similar clustering obeying the power-law distribution defined over a range of lower ($L_{co}$) and upper ($U_{co}$) cut-offs. The calculated fractal exponents ($D$ value with $R^2 = 0.99$) for scoria cones and lava domes are 1.40 and 1.13, respectively. The self-similar clustering suggests that dike intrusions would start at a depth of ~15 km for cones and ~8 km for domes. Notably, the upper brittle crust and the seismogenic zone determined by earthquake catalogue of the region range from 16 to 20 km thick with a maximum of events in between 8 and 10 km. While it remains difficult to constraint the temporal evolution of the CAVP, available geochronology data suggest that domes are younger than cones for some clusters. In addition, most of the monogenetic clusters display self-similar clustering with $D$ values changing from 1.16 to 1.80. The variation in $D$ values and related $L_{co}$ (0.5-0.8 km) and $U_{co}$ (8.5-16 km) values probably indicate the variation in crustal thickness and different crustal fracture distribution (i.e. shallow for domes ~8 km, and deeper for scoria cones ~15 km). On the other hand, the principal component, vent-to-vent distance and Poisson nearest neighbor analyses of monogenetic vents compared with the available structural dataset reveal that there is a significant role of tectonism in the shape of CAVP.

Here, we show that the morphological, spatial and fractal analyses allow us to better constrain the role of the mechanical impact of the crust and the tectonic on the evolution of monogenetic clusters and on the spatial distribution of monogenetic vents.

**Keywords:** Central Anatolian Volcanic Province; monogenetic volcanic field; fractal analysis; spatial analysis; morphological analysis
Morphological and depositional characteristics of Central Anatolian maar volcanoes: Field observations and ‘Structure from Motion’ photogrammetry

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Maars are the second most common monogenetic volcanoes in the world and have been formed by phreatomagmatic or phreatic eruptions. These are one of the most important proxies used in different aspects of the earth sciences (e.g. volcanology, paleoclimatology, and hydrogeology). For instance, maar morphology provides crucial information not only for subsurface geology but also for extra-terrestrial volcanism. Depositional characteristics of maars (e.g. types of juvenile and lithic clasts, clast morphology, sedimentological structures) also contribute to the understanding of subsurface geology and eruption dynamics.

Central Anatolian Volcanic Province (CAVP) includes at least 20 maar volcanoes with various shapes and compositions. These are namely Cora, İnallı, Kalecitepe, Acıgöl-Nevşehir, Güneydağ, Korudağ, İcık, Narlıgöl, Obruk, Yıpraktepe, Leşkeri, Karafatma, Çayankışlası, Develiini, İblizini, Kutören, Acıgöl-Karapınar, Mekegölü, Yılanobruğu, and Mekeobruğu maars from NE to SW. Despite the well-established literature, most of the maar volcanoes in the CAVP are unknown in terms of depositional characteristics. Therefore, we here aim to investigate their morphological and depositional characteristics using the field and laboratory techniques (e.g. creating stratigraphic sections, measuring maximum lithic and juvenile clasts, sieve analysis, 2D clast morphology) and also “Structure from Motion” (SfM) photogrammetry (e.g. high-resolution orthophotos and digital surface models).

The different types of morphologies (e.g. nested or compound) and all characteristic depositional structures (e.g. dune, anti-dune, cross-bedding, sand-waves, impact sags) have been observed in the CAVP maars. There are some spectacular examples for the coalescence of maar volcanoes with lava domes (e.g. Kalecitepe, Acıgöl-Nevşehir) and scoria cones (İcık, Mekegölü). CAVP maars generally predate the adjacent monogenetic edifices (i.e. scoria cones and lava domes), but İcık maar, for instance, postdates the pre-existing scoria cones and presents a footprint-like morphology. The maars in the northern part of the CAVP (except Cora that has andesitic scoria) have pumice and obsidian clasts (lapilli to block size) as juvenile material, whereas those in the southern part include basaltic scoria clasts (lapilli to bomb size). The maximum pumice and scoria clast sizes (long axes) are 15 cm and 35 cm, respectively. Lithic clasts in maar deposits are also various including both basement rocks (e.g. granite, ophiolite) and pre-existing volcanics (e.g. basaltic-andesitic lava flows, scoria clasts). The basement lithics of maars in the northern part of the CAVP (e.g. Acıgöl-Nevşehir, Güneydağ) are especially larger with long axes up to 1 m.

The recent findings on morphological and depositional characteristics of CAVP maars will shed light on the understanding of different types of maar formation in general and also Quaternary monogenetic volcanism in the CAVP with the contribution of ongoing petrographical, geochemical and geophysical studies.

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Keywords: maar; SFM photogrammetry; monogenetic volcanism; physical volcanology; central Anatolia
40Ar/39Ar and U-Pb ages of the biggest Oligocene explosions in the Eastern Rhodopes, Bulgaria and their impact on the Eocene-Oligocene global climatic changes: Preliminary data

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Upper Eocene-Oligocene extension of the Rhodope Massif was accompanied by extensive volcanic activity that produced a number of voluminous silicic eruptions. Such eruptions are typical for continental arcs with a very thick crust, for example, the Rhodopes, where the Eocene crust is considered to have been ~40 -50 km thick. Three of these eruptions produced large volume fall and pyroclastic-flow deposits that covered vast areas in the Central and Eastern Rhodopes, which have been utilised as stratigraphic markers since the beginning of the 1960’s. Traditionally, these eruptions are designated as the First, Second and Third acid horizons. The eruption chronology of the three eruptions has been studied using LA-ICP-MS zircon and 40Ar/39Ar sanidine and biotite analyses, and the three eruptions cover an age interval of ~3Ma. Age estimates for the First acid volcanism fall in the range 33.5 – 34.0 Ma, while the Second and Third acid volcanism events span 32.5-33.0 Ma and 30.8 – 31.3 Ma, respectively. These data were obtained from outcrops in the Eastern and Central Rhodopes, although our preliminary field and mineralogical studies combined with the published age results show that at least the First acid volcanism covers vast areas in Eastern (Georgia, Ukraine) and Central (Hungary, Slovakia) Europe, thus falling in the category of supereruptions. The eruptions of the First and Second Acid Volcanism also resulted in the formation of the Borovitsa caldera (30x15 km), to our knowledge the largest in Europe. The First Acid Volcanism occurred very close in time to the 33.9 Ma-aged Eocene/Oligocene (E/O) climate and extinction turnovers, with largely debated causative mechanisms. The synchronicity of this eruption with the E/O transition indicates that this supereruption, which covers several million km2, could be the most probable cause for the E/O global or at least regional climatic changes.

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Keywords: Rhodope Massif; supereruption; eruption chronology; E/O turnover
Evaluating crust and mantle contributions in Early Oligocene Stomanovo ultra-K monzonite, Central Rhodopes, Bulgaria

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Bratsigovo-Dospat is a large Oligocene (31.38±0.35 Ma) ignimbrite field in the Central Rhodopes which is intruded by the ultrapotassic (ultra-K) Stomanovo monzonite body (30.44±0.22Ma). The ultra-K monzonite has two types of clinopyroxene (CPX) phenocrysts: normally- and reversely-zoned. Normally-zoned CPX is characterized by Mg# (89-74) gradually decreasing from core to rim, whereas reversely-zoned CPX has green Fe-rich (Mg# = 78-55) cores mantled by compositions similar to the normally zoned CPX grains. Neither the core of the normally-zoned CPXs, nor the Fe-rich green cores are in equilibrium with the host monzonite. Normally-zoned CPX and mantles of the green CPXs show decreasing from the core to rim Al₂O₃ and Cr contents, while Na₂O is increasing. Compared to the normally-zoned CPX, the green Fe-rich cores of the reversely-zoned CPX has lower Cr and higher TiO₂, Al₂O₃ and Na₂O. The geochemical characteristics of the normally-zoned cores are consistent with their crystallization from mafic, mantle-derived magma, at depth ~13 km. Fe-rich green CPXs are best interpreted as deep-seated felsic cumulate products from evolved mafic magma. The influx of the mafic magma within the cumulitic high-Fe green clinopyroxenites is the most possible hybridization process that produced monzonite magma. The ultra-K monzonite shows more radiogenic isotopic compositions [(87Sr/86Sr)i = 0.71066 and εNd(t) = -8.0], compared to the host felsic ignimbrites [(87Sr/86Sr)i = 0.70917-0.70927; εNd(t) = -4.6 – -6.5)]. Isotopic data, along with the presence of a large quantity of zircon xenocrysts, whose age matches the ages of the underlying metamorphic basement, suggest a large degree of crustal contamination in the genesis of the monzonite. Our observations indicate complex genesis of the Stomanovo ultra-K monzonite, involving extensive lower crustal fractional crystallization producing residual cumulates and their subsequent mixing with the primitive mantle-derived magmas and accompanying extensive crustal contamination, as demonstrate zircons. We suggest that instead of inheriting their high K₂O and LILE enrichments from slab-derived fluids that metasomatised the magmatic source, the Stomanovo ultra-K monzonites may owe at least some of their high potassium alkalinity to the involvement of biotite-muscovite-K-feldspar from the underlying metamorphic basement of the Rhodopes.

Keywords: ultrapotassic monzonite; green-core CPX; magma mixing; crustal contamination; Rhodope Massif
In the present study, we examine the petrographic and geochemical characteristics of the contact metamorphic rocks of Dikeos Massif in Kos Island (Dodecanese), Greece. Kos is located on the eastern edge of the Aegean Volcanic Arc. The volcanic activity of the island has been developed firstly through the Miocene magmatism and the intrusion of the I-type pluton and secondly through the Plio-Pleistocene Kos Plateau Tuff eruption (KPT), the largest Quaternary eruption in the eastern Mediterranean, whose products are mainly found in the western part of the island. The intrusion of the Miocene pluton caused contact metamorphism of albite-epidote to hornblende hornfels facies on the neighboring rocks. The hornfelses formed are characterized by a variety of mineral assemblages depending on the mineralogical composition of the protoliths and the metamorphic conditions they experienced. Through the petrographic analysis, the mineralogical assemblages were studied and their protolith composition was constrained. The textural characteristics of the samples examined, provided important information about the replacement reactions occurring among the minerals phases, which indicate that equilibrium was only partially attained. The phase relations identified are illustrated employing ACF and AFM diagrams, wherein the bulk chemistry of the studied rocks is plotted. The questions raised through this study, need further research and could provide important information for the petrologic development of the hornfelses, and the conditions of the replacement reactions of the minerals.

**Keywords:** Kos; hornfels; petrology
Mineral chemistry and termobarometric implications on Miocene volcanics in the northern part of Afyon Volcanics, Western Anatolia

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Kirka-Afyon-Isparta Volcanic Province (KAIVP) is regarded as one of the best regions where studied the origin and petrological evolution of the high potassium volcanic activity. Volcanic rocks in the region have geochemical diversity that is controlled temporally and spatially. Alkaline and ultrapotassic volcanic rocks of Afyon volcanism are accepted as the first products with asthenospheric effect after orogenesis in Western Anatolia. In this study, the mineralogical-petrographical properties of Karakaya volcanics at Afyon Volcanism are determined and by the help of the microprobe analyses, estimated thermobarometers are calculated. As a result of petrographic and mineral-chemical characteristics, Karakaya volcanics have been renamed by subgrouping in this study. These volcanics are named as Seydiler Ignimbirite (SI), Isehisar Basaltic trachyandesite (IBT), Çalışlar trachyandesite (ÇT), Ağm trachyte (AT) and Karakaya lamproite (KL). According to major element geochemical data, IBT (49.2<SiO\textsubscript{2}<52.2) and ÇT (51.9<SiO\textsubscript{2}<54.6) have shoshonitic character, while AT (59.2<SiO\textsubscript{2}<60.65) and KL (49.8<SiO\textsubscript{2}<59.9) have ultrapotassic character. The pyroclastic rocks of SI (57.07<SiO\textsubscript{2}<76.50) are all in the rhyolitic and high-potassium calc-alkaline series. The majority of the samples displaying hypocrystalline porphyritic texture whereas samples of KL have holocrystalline texture. Generally, the suites also exhibit some textural evidence of disequilibrium crystallization such as sieve texture and corrosion in plagioclase phenocrysts, zoning, and inclusions in clinopyroxene phenocrysts. Mineral chemistry studies show that clinopyroxenes in all suites are augite and diopside in composition, varying from Wo\textsubscript{35}En\textsubscript{41}Fs\textsubscript{4} to Wo\textsubscript{45}En\textsubscript{47}Fs\textsubscript{8} from Wo\textsubscript{45}En\textsubscript{10}Fs\textsubscript{15} to Wo\textsubscript{56}En\textsubscript{37}Fs\textsubscript{10}, respectively. Feldspars generally exhibit a wide range of compositions from sanidine to albite and andesine in IBT and ÇT, but sanidine observed only in AT and KL. Olivines observed in ÇT, KL and a small group of IBT have a compositional range from Fo\textsubscript{80} to Fo\textsubscript{93}. Micas are identified as phlogopite in composition with FM (Fe\textsuperscript{2+}/(Fe\textsuperscript{2+}+Mg)) 0.18–0.40 in AT and KL. Fe-Ti oxides in all suites are generally magnetite in compositions. Leucite and analcime possibly derived from leucite minerals were found in all groups analyzed by X-ray diffractions. Mineral thermobarometric estimations in all suites were tested on clinopyroxene, feldspar and olivine compositions taking account approaches of different authors. Temperatures values varies from 1234-1105 °C for IBT, 1273-1147 °C for ÇT, 1163-1127 °C for AT to 1258-1138 °C for KL. Pressure ranges from 6.1-5.6 kbar for IBT, 7.3 kbar for ÇT, 6.1 kbar for AT to 12.2 kbar for KL suite. Based on the temperature and pressure values calculated from the mineral-melt associations in the studied volcanics suggest that Afyon volcanics can be affected by magma mixing process may be crystallized at different depths during the transport of magma.

Keywords: mineral chemistry; thermobarometry; KAIVP; Karakaya volcanics; Western Turkey
Widespread volcanism occurred in the Central Anatolia during the Quaternary time, as a consequence of the continental collision among Eurasia, Africa, and Arabia plates. As a result of this event, the southern part of the Eurasian plate was dismembered and, subsequently, the Anatolian block began independent, starting to move westward along the North Anatolian Fault and the East Anatolian Fault. In this scenario, the petrological evolution of the volcanism is strictly related with the tectonic evolution of the area. The Cappadocia region is confined by distinctive strike-slip fault systems, namely Tüzgölü and Ecemiş, and it is characterised by volcanic products with bimodal petrological and geochemical features. We focus here on the Plio-Pleistocene monogenetic activity, which produced two types of rocks: i) calc-alkaline volcanic rocks, ranging from basalts to rhyolites, and outcropping around Acığöl caldera, Göllü Dağ dome, and Hasan Dağ and Erciyes Dağ volcanoes; ii) Na-alkaline volcanic rocks ranging from alkali basalts to mugearites, and outcropping in Karapınar, along the WSW flank of Hasan Dağ, in Acığöl and along the Kızılırmak fault. No clear evidences for a time-related shift from calc-alkaline to Na-alkaline volcanism is observed, differently from what occurring in the Western and Eastern Anatolia regions in which calc-alkaline products are distinctly older that Na-alkaline ones. In the Cappadocia region, calc-alkaline and alkaline rocks have similar ages (1.98-0.018 Ma), and sometimes a complete time overlapping between subduction-related and within-plate volcanic rocks is observed. The Sr-Nd radiogenic isotopic composition of both rock types show a narrow, overlapping range of values: calc-alkaline rocks range from 0.70395 to 0.70474 and 0.51268-0.51281, whereas Na-alkaline magmas from 0.70334 to 0.70524 and 0.51268 to 0.51293 for $^{87}$Sr/$^{86}$Sr and $^{143}$Nd/$^{144}$Nd, respectively. Most of the Na-alkaline products, like calc-alkaline magmas, are characterised by enrichments in LILE and negative HFSE anomalies. Then, true intraplate-like magmas do not occur in Cappadocia, where the genesis of Na-alkaline magmas is ascribed to mixing between different percentages of within-plate and subduction-modified magmas. According to geochemical modelling, the addition of 13 to 30% of OIB-type melt to calc-alkaline magmas is enough to change a SiO$_2$-oversaturated magma into ol-hy-normative and ne-normative, whereas the addition of 15% of calc-alkaline magma to an OIB-type magma is enough to generate negative Nb-Ta anomalies. The large geochemical variability of the products emplaced in the Cappadocia region reflect the complex tectonic setting of the Central Anatolia characterised by strike-slip tectonics and local extensional pull-apart basins; in this scenario, different magmas formed contemporaneously through decompression melting at different depths. The calc-alkaline magmas derive from partial melting of a mantle wedge modified by subduction component, whereas within-plate (OIB-like) rocks derive from deeper, unmodified sub-slab mantle source. These magmas rise to the surface in response to strike-slip faulting associated with the formation of pull-apart basins. The very low rate of extension allowed within-plate magmas to reach the surface only after having interacted with the overlying calc-alkaline magmas in the last stages of Cappadocia volcanism.

Keywords: Cappadocia; monogenetic volcanism; magma mixing
Abundant alkali basaltic magmatic activity occurred around the northern termination of the Dead Sea Fault Zone, and in the North-West foreland of the Arabian plate, during the Early Miocene to Pleistocene time. During the Pleistocene, volcanism developed around the Anatolia-Africa-Arabia triple junction, in Kahramanmaras, along the Karataş-Osmaniye Fault, and along the termination of the Dead Sea Fault, in the Karasu Valley. Further East, widespread volcanic activity developed within the Gaziantep Basin during the Early-Late Miocene (21.2-7.0 Ma), and in the Karacadag Shield Volcano since the Middle Miocene throughout the Pleistocene (12.1-0.01 Ma). The volcanic products emplaced in these areas are mainly basaltic and basanitic in composition, with subordinate hawaiites and basaltic andesites. They mostly show Na-alkaline affinity, even if some of the older products display a calc-alkaline signature. The rocks outcropping in these regions show LREE/HREE and HFSE/LILE ratios which are similar to the typical OIB-like magmas. Chemical variations observed, clearly suggest that these magmas evolved by low pressure crystal fractionation of typical basaltic assemblage consisting of Olivine±Clinopyroxene±Plagioclase±Fe-Ti oxides. Radiogenic isotopes (\(87Sr/86Sr \approx 0.70301-0.7050 \), \(143Nd/144Nd \approx 0.51266-0.51304\), \(206Pb/204Pb \approx 18.80-19.22\), \(207Pb/204Pb \approx 15.59-15.74\), and \(208Pb/204Pb \approx 38.77-39.32\)) show wide variations, suggesting assimilation of crustal material during magma ascent to surface. In the light of this, the LILE enrichments in the samples showing calc-alkaline affinity and higher \(87Sr/86Sr\) values are interpreted as due to the assimilation of crustal material by primary Na-alkaline magmas. Significant trace element and isotopic differences also occur when considering only the most primitive samples (MgO>8 wt.%). These variations cannot be explained with Assimilation-Fractional crystallisation processes, and then the occurrence of a heterogeneous mantle source and different melting processes is invoked. REE modeling indicates the occurrence of partial melting of variable percentage (2-9%) of a garnet-bearing peridotite, resulting in high LREE/HREE (i.e., La/Yb) and MREE/HREE (i.e., Dy/Yb) ratios. The results of geothermobarometric estimates for the study rocks indicate melting of the mantle source at potential temperature and pressure variable from 1480-1530°C and 29-35 Kbar for the Pleistocene Osmaniye and Karasu Volcanic Fields in the Dead Sea Fault Zone. Estimates of 1400-1450°C and 15-19 Kbar resulted for the Early Miocene Gaziantep volcanism, and 1500-1525 °C and 25-32 kbar for Plio-Pleistocene activity of Karacadag Volcanic Fields in the North-West Arabian foreland. The P-T variations are well correlated with radiogenic isotopes, with the younger magmas characterised by the lowest Sr-isotopic compositions and the highest Pressures, indicating a heterogeneous mantle source, with less depleted domains towards the surface and a more depleted component at greater depths. The occurrence of intense and very long-lasting (20 Ma) alkali basaltic activity in the foreland of a convergent tectonic system, is rather uncommon; one possible interpretation is the northeast mantle flow as suggested by the undulated pattern of the relatively “westerly” moving lithosphere. The mantle previously underwent partial melting beneath the Red Sea rift. Local tensional and transtensional tectonics adjacent to the Dead Sea transform fault system may have allowed the mantle melt uprise.

**Keywords:** Cenozoic volcanism; Arabian Plate; alkali basalts
A3. Magmatic Geodynamics & Volcanology in the Mediterranean Region
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A3-20

Geochemical-petrological characteristics and U-Pb zircon geochronology reveal the emplacement history of the Turgutreis-Bodrum Monzonite, southwestern Anatolia, Turkey

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The Late Miocene igneous rocks of the Bodrum magmatic complex (SW Anatolia, Turkey) are composed of monzonitic stock (Bodrum monzonite), andesitic to rhyolitic lavas and associated pyroclastic rock successions. The Bodrum monzonite intruded into the Upper Santonian–Campanian flysch-like deposits of the Karabörten formation and limestone blocks of the Lycian nappes. At the eastern margin of the pluton, skarn alteration zones occur along the contact between monzonite and limestone.

The Bodrum monzonite (BM) is mainly made up of plagioclase, biotite, hornblende, pyroxene, quartz and opaque minerals, and is geochemically belong to high-K calc-alkaline to shoshonitic, metaluminous series. The monzonite shows very narrow range of initial Sr (~0.70623) and Nd (~0.51253) isotopic ratios.

The major and trace element geochemical features (large ion lithophile elements enrichment over high field strength elements), as well as mineralogical-textural evidence, suggest that the BM formed in volcanic arc setting. Moreover, it is revealed that the BM was derived from enriched mantle, and the parental melts underwent upper crustal contamination coupled with mineral fractionation.

The zircon U-Pb age for the Bodrum monzonite is 8.6±0.04 Ma. In addition, the core of the zircons yields 9.43±0.34 Ma age. Furthermore, the morphologies of the zircons from the monzonite samples are typologically classified by the classical "Pupin method", and suggest crystallization temperatures ranging from 650 to 700°C.

Keywords: zircon; monzonite; Turgutreis-Bodrum; Western Anatolia; Turkey
Scientific Session A.4

Cenozoic Extensional Tectonics in the Eastern Mediterranean Region

Conveners:
Dr. Konstantinos SOUKIS; Dr. Talip GÜNGÖR
Late Oligocene – Early Miocene deformation in the Thrace Basin and the structure of the Koru Dağı, NW Turkey

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Thrace Basin is a large post-collisional Eocene-Oligocene sedimentary basin in the North Aegean region. Along the southern part of the Thrace Basin, there are several deformational structures (e.g. Ganos monocline, Gelibolu folds) located north and south of the Ganos Fault. The Koru Dağı (Koru Mountain) is one of these structures in the Thrace Basin. We have investigated structural and stratigraphic features of the Koru Dağı to understand the nature of the deformation in the Thrace Basin and also used U-Pb zircon geochronology to constrain the exact time of the deformation. The Koru Mountain is a large, upright horizontal, asymmetric anticline, 35 km long and 9 km wide, and extends in ENE-WSW direction. The fold axis of the anticline is N65°E nearly parallel to the Ganos Fault. The sharp southern margin of the Koru Dağı is induced by a blind thrust fault and characterizes an asymmetric structure. Stratigraphically, the Koru Dağı anticline consists of Late Priabonian (shallow-benthic-zone- SBZ- 20) shallow marine limestones and an overlying thick siliciclastic turbidite sequence with some tuff horizons. U-Pb zircon ages collected from one tuff sample give Early Rupelian (31 Ma) age. Eocene-Oligocene sediments of the Koru Dağı anticline are unconformably overlain by the Late Miocene (Valesian/MN9) lacustrine sandstones, conglomerates, and subordinate limestones. Such a stratigraphy clearly indicates that the Koru Dağı anticline formed in the Latest Oligocene-Middle Miocene. We interpret this deformation as a part of buckle type fold system evolved along the southern part of the Thrace Basin. The geometry of the Koru Dağı and related folds indicate NNW-SSE contraction during the Late Oligocene and Early Miocene in the Thrace Basin. This period corresponds to an unconformity in the Thrace Basin with the Eocene-Oligocene sequences overlain by Miocene continental series over wide areas.

Keywords: Koru Dağı; Thrace Basin; buckle fold; Ganos Fault
The Eocene (45 Ma) Northern Kapıdağ Pluton (NKP) is located at the Kapıdağ Peninsula (NW Turkey) and represented by a plutonic body which was intruded into the basement rocks of Erdek Complex. The southern part of the NKP is formed from granodiorite with holocrystalline granular texture. Through the northern parts, granodiorite gradually passes into deformed granodiorite in which magmatic textures are mostly overprinted by intra-crystalline deformation.

Microstructural analysis of the NKP displays that the northern part of the NKP is affected by solid-state deformation which is classified as ductile deformation with high temperatures and ductile-to-brittle deformation with relatively lower temperatures. The ductile deformation of NKP is evidenced by micro-structures such as chess-board extinction, grain boundary migrations (GBM), sub-grain rotations (SGR) and myrmekite development suggesting a temperature between 600 and 400°C. This ductile deformation is overlaid by ductile-to-brittle deformation which is defined by bulging recrystallization (BLG) of quartz, grain size reduction of mica crystals and micro-cracks and faults on feldspars which develop between 400-< 250°C temperatures.

All of these field and micro-structural data collectively suggest that the structural evolution and deformation history of NKP may have been controlled by a normal dextral fault dipping towards north located at the northern edge of the Kapıdağ Peninsula.

**Keywords:** Kapıdağ Pluton; micro-tectonics; ductile deformation; brittle deformation; NW Anatolia
Along the deformation zone of the North Anatolian Fault Zone (NAFZ), the Bursa Fault is described as Holocene Fault on active fault map of the region. There has been still an active debate in the literature about whether it belongs to NAFZ or Eskişehir Fault Zone. To solve this problem, we mapped active fault segments along the southern boundary fault of the Bursa basin, documented its kinematic properties, and manifested its relationship between older structures.

According to field studies, the stratigraphy of the Bursa region includes two main rock packages. From older to younger; (i) basement rocks consisting of Paleozoic-Mesozoic metamorphic rocks and Miocene volcano-sedimentary rocks, (ii) Quaternary infill of Bursa basin composed of alluvial fan, alluvial plain and colluvial deposits. Faults around the Bursa region are separated into three groups in terms of their activities. These are, older to younger; (i) Pre-Quaternary faults, (ii) Quaternary faults, and (iii) Holocene faults. Based on fault kinematics, the NE-SW trending Pre-Quaternary faults are mainly classified as dextral strike slip faults, whereas the E-W trending Quaternary-Holocene faults are normal in character.

Kinematic data yielded from faults along the Bursa basin shows that region has experienced two different paleo-stress states since Miocene. The first one is related to Pre-Quaternary faults and is calculated as NE-SW trending contraction and associated NW-SE trending extension. The second one is associated with Quaternary and Holocene faults and is calculated as a NE-SW trending extension. The Bursa Fault and Bursa basin have formed during the still ongoing second stress phase and belong to the North Anatolian Fault (deformation) Zone.

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Keywords: Bursa Fault; stratigraphy; fault kinematics; paleostress; North Anatolian Faut Zone
The Central Anatolian basins have various spatiotemporal deformations of the neotectonic regime which is effective in Anatolia. These basins show intense deformations in the Central Anatolian Region, different tectono-stratigraphic evolutions have taken place as a result of the collision of Pontide and Anatolide-Tauride blocks. One of the best examples is the Sivrihisar-Polatlı Neogene Basin. The study area is located between Mihaliççık and Sivrihisar in this basin. The basin is represented with the Mesozoic basement rocks of Tavşanlı Zone, which is unconformably overlain by the Neogene fluvial sedimentary units. The Neogene deposits include clastics, carbonates and evaporitic units. During the deposition of Neogene units, climatic changes and effects of the tectonism caused sharp and transitional succession in the basin. According to the field investigations, paleo-stress analyzes and earthquake focal mechanism solutions can be considered that the study area is under the influence of three different tectonic regimes. These are (1) the nearly N-S oriented tensional stress extensional regime affecting the Miocene-Pliocene interval of the region, and (2) the transtensional regime which was formed under NE-SW oriented tension associated with NW-SE oriented compression, that was effective from the Pliocene to Pleistocene (?), and (3) the transpressional regime, derived from NW-SE compression associated with NE-SW tension which is active today. The last regime is also supported by focal mechanism solutions of two earthquakes, expressing reverse faults with strike-slip component. Considering the field observations, paleo-stress analyzes and earthquakes focal mechanism solutions, it can be inferred that the region may represent seismic activity due to ongoing tectonic regime that are effective in the region, it may be seen that the region continues its seismic activity nowadays.

**Keywords:** Sivrihisar-Polatlı Basin; İnönü-Eskişehir Fault System; Neogene; paleo-stress analyses; tectonic regime
Porphritic domes and normal fault in strike-slip environment. Examples from Tunceli and its surroundings: Preliminary approach

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Eastern Anatolia located at 2000 meters above sea level, has a strategic importance to understand regional tectonic regimes associated with magmatic evolution with diverse chemical compositions. The tectonic setting of Eastern Anatolia dominated, at least in the last 12 Ma, by the strike-slip tectonics, represents the uplifted plateau consisting of a complicated mosaic of tectonic units joined during the Alpine-Himalayan Orogeny. The right-lateral North Anatolian Fault Zone (NAFZ initiated ~12 Ma, trending WNW and NW), together with the conjugate East Anatolian Fault Zone (EAFZ activated around 6 Ma ago and left lateral, NE trended), meeting in Karlıova, controlling the tectonic feature of the area, which accommodates many parallel structures all around the Eastern Anatolia (local mosaic tectonic areas). Some of the recent studies carried out by diverse authors mentioning about the vertical component of the dominant horizontal tectonics in eastern Anatolia (Sigma 1 in vertical). Although it is too early to explain the cause of this vertical component of horizontal tectonic, there are also publications suggesting its connection with young volcanism.

This situation, observed in and around Tunceli where normal faults are the vertical components of dominant horizontal lineaments. These processes of transform to the normal faults are the temporary products of buoyance force of Miocene-Pliocene magmas. Explosive activities cause to reduction of the gas phase in the melt, whereby the viscosity and the melting temperature of the melt increase. Therefore, the temperature in the upper part of the magma chamber is insufficient to remain in the melt phase, so start the last and rapidly microscopic crystallizations and solidification (yet hot and ductile) of intrusive porphyritic rocks with following dyke swarms. Within above mentioned mosaic structure huge amount intrusive - sub volcanic porphyritic domes (15 – 16 Ma) are locating on survey along the faults parallel to much younger tectonic lines (NAF 12 Ma and EAF 6 Ma in age). Therefore their arriving on the surface is not explainable with magma rising. Because of the completely solidified porphyritic cover bodies and related younger dykes on and around it, younger magma is not able to cut and rise this batholithic body. So the buoyance force will become active.

The rise of these sub volcanic solid rocks bouquet from underground to surface is explainable only by the fact that younger magmas at the base lift them up (buoyance force) together with other neighbor rock groups. This means that buoyance force caused temporary transform of horizontal tectonics to vertical tectonics within the study area. This wide spread on the surface reflects the huge amount porphyritic batholith in the deep blockading of the magma rising from the younger magmas at the base, which activated the buoyance force.

Keywords: porphyritic domes; buoyance force; normal fault components of strike – slip tectonic.
Scientific Session A.5

Seismology, Seismotectonics and Geodynamics in the Aegean Region

Conveners:
Dr. Anastasia KIRATZI; Dr. Zafeiria ROUMELIOTI;
Dr. Semir ÖVER
The aim of this study is to investigate lithosphere and mantle structure of the Western Anatolia. Teleseismic phase readings have been inverted using teleseismic tomography in order to create a 3-D image of the underlying mantle beneath Western Anatolia. Investigation of heterogeneous mantle structure, determination of the geometry of subduction zones, and delineation of fast seismic velocity anomalies can be achieved using seismic tomography. In this study, we used 15,624 direct P phase arrival times from 126 earthquakes recorded at a variety of permanent seismic networks (Boğazici University, Kandilli Observatory and Earthquake Research Institute and Disaster and Emergency Management Authority). In order to increase the station coverage and increase the resolution, we selected arrivals from earthquakes with moment magnitude 5.5 and greater (Mw>5.5) at distances between 28° and 90° from the stations for direct P phases (126 earthquakes). Arrival times were picked on seismograms filtered in four frequency bands with corner frequencies of (0.1 -0.4Hz, 0.05- 0.1 Hz, 0.02 – 0.8 Hz, 0.5-20 Hz ) and 0.05–0.15 Hz for all stations. After combining data sets, relative arrival time residuals and errors were determined with respect to the ak135 one dimensional global velocity models using the Adaptive Stacking Method. After combining data sets, relative arrival time residuals and errors were determined with respect to the ak135 one dimensional global velocity model using the Adaptive Stacking Method. These results were used in the fast marching teleseismic tomography inversion and we have obtained new three-dimensional (3-D) P-wave velocity perturbations of the mantle beneath Western Anatolia down to about 700 km depth. Based on the obtained tomographic cross-sections the geodynamic structure of the region has been interpreted. The tomographic results show the existence of two distinct high velocity anomalies in the mantle. Seismic tomographic cross-sections clearly show the northward subducting African slab as well as the low-velocity subduction wedge located between this slab and the Aegean continental lithosphere. This low-velocity wedge can be interpreted as the mantle source region of the active Aegean arc volcanism. The obtained tomographic results also indicate the presence of a distinct, southward subducting, high-velocity zone in the north. This high-velocity zone, which is located beneath the Marmara Sea, extends down to 350 km and it consists of two oceanic lithospheric pieces that are detached at about 200 km depth. This high-velocity zone can be interpreted as the remnant of the southward subducting Black Sea oceanic lithosphere. The Oligocene aged (approx. 30 million years) magmatic rocks in the north Aegean and Marmara regions can be explained as the products of the southward subduction of the Black Sea oceanic lithosphere. A high velocity zone that would be expected from the İzmir Ankara-Erzincan suture zone was not observed, in this study.

**Keywords:** geodynamics; teleseismic tomography; Western Anatolia
On the Operation of an Earthquake Early Warning System at the Hellenic Subduction Zone

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The southern Aegean area presents a long history of large magnitude earthquakes that caused extensive destruction in the south-eastern Mediterranean land. Most of these events are directly associated with the subduction of the eastern Mediterranean lithosphere beneath the Aegean plate along the Hellenic arc and are, thus, of intermediate-depth. However, several historical destructive earthquakes are considered to be associated with shallower tectonic processes such as the 365 CE, M8.3 earthquake to the west of Crete Island, which has been described as a “global earthquake” by historians of the time. In this work we test the feasibility of PRESTo (PRobabilistic Evolutionary early warning SysTem) for issuing earthquake early warnings at several densely populated areas in the southern Aegean area. Our tests involve the back-playing of data from permanent monitoring networks in Greece and from all earthquakes of magnitude ≥5.0 that have occurred in the southern Aegean area since 2011. We specifically focus on a) examining the reliability of issued warnings in terms of accuracy in earthquake location and magnitude, b) examining the capability of network-software combination to distinguish between shallow and intermediate-depth earthquakes (i.e., accuracy in fast focal depth determination and c) assessing the time required until the issuing of a stable estimate of earthquake location and magnitude for various parts of the study area and consequently the order of magnitude of the reaction time at selected densely populated areas that future warnings may provide. We conclude that existing permanent networks in Greece provide sufficient sensor density that allows the correct distinction between shallow and intermediate-depth earthquakes. Overall, earthquake locations and magnitude assessments are within acceptable uncertainty intervals at the initial warning time, while early warnings often provide lead times of the order of several tens of seconds to several sites, especially in cases of deep events. Although this study is based on back playing data of past earthquakes alone, its results are promising for the immediate pilot operation of an earthquake early warning system in southern Aegean using the existing networks as backbone infrastructure.

Keywords: Hellenic subduction; earthquake; aegean
Tectonic settings and neo-tectonics of the Aegean Sea as deduced from satellite altimeter and gravity data

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The Aegean Sea is one of the key regions for the understanding of fundamental tectonic processes, including continental rifting, passive margins, ophiolites, subduction, accretion, collision and post-collisional exhumation. It is also ideal for understanding the interaction of tectonic, sedimentary, igneous and metamorphic processes through time that eventually lead to the development of an orogenic belt. Below, we will outline some milestones in the development of tectonic-related research in the Aegean Sea region. In addition, the continuous seismicity attributed to its tectonic settings, which affect almost all countries surrounding this region indicates the activities of these tectonics. Thus, tectonics and geodynamics of this region have been always the attention of many interested in earth sciences.

Radar altimetry data has been used to derive gravity and its variations over the world's oceans and an excellent tool for mapping sea floor structures, including tectonics, sea mounts and rifts. On the other hand, the Gravity Recovery and Climate Experiment (GRACE) satellite mission has widely demonstrated its sensitivity to ongoing mass redistribution within the various sub-systems of the earth. Finally, GOCE (Gravity field and steady-state Ocean Circulation Explorer) satellite is the first satellite mission that observes gradient of the Earth gravity field from space. Integrated satellite gravity data have been used to delineate the tectonic settings and the neo-tectonics of the Aegean Sea.

Results show important zones of mass discontinuity in this region correlated with the seismological activities and temporal gravity variation. The study indicates the importance of considering spatial and temporal gravity to the deformation and tectonic studies for completeness of the geodynamic studies. Generally, it can be stated that the satellite data offer additional and complementary data sets to help the geoscientists to determine the Earth’s internal structure and tectonics. Determination of spatial and temporal earth’s gravity field from satellite opened new perspectives on earth sciences and provides valuable information of the geodynamic studies. The current study indicates that satellite gravity data is a valuable source of data in understanding the geodynamical behavior of the studied region.

Keywords: gravity; climate geodynamic; seismicity; earthquake
Near-field Source Model for the 2017 Bodrum-Kos Earthquake (Mw=6.6): Triggered Off-fault Events to the Northeast of the Ruptured Fault Plane

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The Bodrum-Kos earthquake initiated a long lasting debate on the dip of the fault plane where authors give arguments both on a south dipping and north dipping planes. Here, we contribute on the subject by using Coulomb stress change estimation technique as a tool to discriminate between the two nodal planes. The stress changes associated with a mainshock primarily dependent on the properties of the source model.

Large variety of fault planes solutions have been derived for the Bodrum-Kos mainshock mechanism showing faults striking from NNW-SSE to NNE-SSE, rakes indicating oblique to pure normal faulting and also mechanisms portraying from shallow to steeply dipping planes.

As such, here we firstly try to establish a source model based on near-field data and then use that model to estimate the Coulomb stress changes. The resulting stress maps estimated for the optimally oriented strike-slip and normal faults are compared with the aftershock distributions to see which of the nodal planes provide better correlation with the region of increased stresses.

A near-field five-station strong motion network located in Bodrum Peninsula have been used to infer a rupture model for the July 20th, 2017 Bodrum-Kos earthquake. The accelerometric stations of the local network are located on the hanging wall of the plane extending northeast from its surface trace located offshore Kos island. The data used have been augmented including nearby accelerographs operated by AFAD and NOA-EIDA node.

Thus acquired mainshock accelerograms have been integrated twice to get displacements which were then inverted to their sources to retrieve source parameters for the mainshock through searching for the best CMT location on a 3-D grid scheme. The results indicate that the best CMT point is located at 6 km depth and shows predominantly normal faulting mechanism with a considerable strike-slip component; where left-lateral strike-slip motion has been derived on the nodal planes striking NW-SE and dipping NE, while the sense of motion is right-lateral-strike-slip on the plane extending NE-SW and dipping SW.

A 50 x 20 km fault plane has been parameterized to have 40 elements each of 5 x 5 km size; 10 of them are located along the strike and 4 along the dip. Ultimately, the best fit CMT parameters have been utilized to get a slip distribution model where the moment release on each sub-fault are derived; essentially, needed for Coulomb failure stress calculations.

The results indicate that the Coulomb stress changes associated with the northeast dipping nodal plane shows very well fit between the aftershock distributions taking place to the NE of the ruptured fault plane and the region of increased coulomb failure stress changes estimated for the optimally oriented normal and strike-slip faults. Despite the distance to the ruptured fault plane and the time delay since the origin of the mainshock those off-fault events can be classified as aftershocks taking into account the space and time window length for Mw=6.6 event.

Keywords: Bodrum-Kos earthquake; finite source model; coulomb stress
Contribution in determination of the tectonic setting of Corinth Gulf based on primary geodetic data processing

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Corinth Gulf region is characterized by high tectonic activity, as numerous active fault zones are documented in the broader area. The N – S extensional regime of the area resulted in the occurrence of the roughly E – W aforementioned fault zones, while several of them are related to the seismicity of the region.

The use of satellite geodesy is a modern way of determining the tectonic regime in tectonically active regions like Corinth Gulf. 14 permanent GPS/GNSS stations are installed in the study area, collecting primary geodetic data for 7 consecutive years (2008-2014), while each station geodetic observation was recorded every 30 seconds on a daily basis, leading to the estimation of stations velocity.

The processing of primary geodetic data was carried out by implementing the triangulation methodology, based on the data combination of three GPS/GNSS stations, resulting in the extraction of several parameters and therefore the interpretation of the tectonic setting and the geotectonic evolution of the study area. In total 26 triangles have been constructed for the study area, while the estimated parameters are: a) maximum horizontal extension, b) total velocity, c) maximum shear strain and d) area strain.

Keywords: active tectonics; satellite geodesy; Corinth Gulf
Decomposition of Site Terms from the Response Spectral Values: a case study for western Anatolia, Turkey

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Separation of source, site and propagation characteristics plays a crucial role in seismic hazard assessments. Estimation of site effect (site response or site transfer function) is one of the main goals in seismology, since increase in damage due to varying amplification level of different wave phases in the ground motion. The need for site-specific seismic hazard analysis is crucial for deep sedimentary basins. Site amplification at deep sedimentary basins is an important parameter for modeling of the spectral amplitudes of the ground motions due to resonance effect of soil column thicknesses, causing damage. Western Anatolia region is one of the world’s best examples of a rapid intra-continental extension with horst and graben structures, including composite basins and comprising multiple depocenters or subbasins. Moreover, dense and large cities on deep basin/graben structures increase seismic risk potential of the region. Therefore, it is necessary to obtain site terms and to develop site-specific ground motion prediction models for the region. These models are given together with a logarithmic standard deviation, which is referred to as sigma ($\sigma$) and involves both aleatory variability and epistemic uncertainty. The single-station sigma analysis is driven by the need to decrease in uncertainties of probabilistic site-specific seismic hazard assessments.

This main aim of this study is to obtain site terms for 29 different locations in western Turkey, utilizing single-station sigma analysis to response spectral values of 1764 three-component recordings from 322 local earthquakes. The results were compared with the site terms from the S-wave Fast Fourier Transform (FFT) amplitudes by Akyol (2018). Utilizing the single-station sigma analysis, residuals of the median models were decomposed to obtain site terms. The median models were derived by utilizing the MLR procedure which performs the maximum likelihood (ML) estimation of mixed models where the fixed effects are treated as random (R) effects with infinite variance. An average sigma for the median models is about 0.401 log10 units (±0.019) and decreases to about 0.307 (±0.018), after taking into account the single-station sigma site terms (~23% reduction). Consistency was observed between the single-station site terms from the response spectral values and the S-wave FFT amplitudes. The results imply that the frequency-content differences, between the response spectral values and the S-wave FFT amplitudes, affect on the $ss_s,s$ values (site-specific event-corrected within-event standard deviation) rather than the single-station site terms or the $ss$ values (event-corrected within-event standard deviation from overall data). Additionally, horizontal to vertical spectral ratio of the response spectral values were calculated and compared with obtained single-station site terms.

Keywords: single-station sigma analysis; site term; horizontal to vertical spectral ratio; site-specific response spectra; uncertainties in response spectra modeling; Western Anatolia; Turkey
The North Anatolian Shear Zone (NASZ) is a ~1400 km long active strike-slip shear zone connecting the Eastern Anatolian convergence and the Aegean subduction zone. As an active plate boundary, the NASZ is currently accommodating 23-24 mm yr⁻¹ of dextral motion between the Anatolian and the Eurasian plates. The cumulative offset and the age of the NASZ are still been controversial especially along its western part, in the Marmara Sea Region. There are two main opposing views on the cumulative offset along the NASZ. According to the first view the total offset of the NASZ decreases gradually from Eastern Turkey towards the Aegean Sea; from ~90 km in the east to 30–75 km in the central and to 25–20 km in the western part of the NASZ. On the contrary, the second view suggests no gradual decrease of offsets along the shear zone, and the cumulative offset of the NASZ remain constant as ~90 km from eastern to western Turkey. In the present study, I review both published and unpublished structural data collected offshore and on land parts of the Western Marmara Region. This review manifests that the NASZ is made up of 14 fault zones forming a ~140 km wide complex shear zone between 29°E and 27°E longitudes. Combination of the previously reported and new offset structures, defined during the present study, evidence that the total dextral displacement along the NASZ is partitioned by these 14 fault zones. As a result, I have measured a total of ~80 km maximum dextral slip along the NASZ, in the Western Marmara Region. This cumulative displacement value is in good correlation with the recently reported total 88±5 km offset in the Eastern Marmara Region, near 31°E longitude. The ~23 mm yr⁻¹ of total plate motion of the Anatolian Block along the NASZ and the accumulated ~89 km total offset suggests that the initiation of transform displacement started at Pliocene (3.9 Ma) across the Marmara Sea. The age of the river network that widely offset by the NASZ and offshore seismic reflection data reported in the northern Aegean Basins also supports Pleistocene inception of the NASZ, in the Marmara Sea Region. All of these data evidenced no gradual decrease of offsets along the NASZ from eastern to western Anatolia.

**Keywords:** cumulative offset and age; North Anatolian Shear Zone (NASZ); offset partitioning; Western Marmara
Underlying causes of the extensional deformation in Western Anatolia

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A peneplain plateau is present on the top surface of raised crust of the western Anatolian that is sliced by low angle detachment fault systems. Not a continental collision that is a main topic in tectonics but a vertical (up flow) support of the hot mantle is responsible for the abnormal high elevation of the crust and its surface topography i.e., the positive residual surface topography of the western Anatolian crust. In addition, this up flow is also responsible for the north-south stretching of overlying crust and associated detachments and exhumed zones of core complexes in western Anatolia. The distinct positive anomaly of the residual topography in western Anatolia marks the boundary of the metamorphic-core-complex in the western Anatolia. This model can explain both uprising and extension of the crust which results in detachments and accompanying normal fault systems in the western Anatolia.

Keywords: Western Anatolia; deformation; extension; detachment
Strong-Motion Seismic Monitoring for Engineering Applications in SW Turkey

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Bodrum and Datça peninsulas located in the province of Muğla, are situated on the southwest coast of Turkey. This is one of the seismically active regions of the southeast Aegean Sea. The Gökova Graben, the Datça faults, the eastern part of the Hellenic Volcanic Arc and Trench system are prominent seismic sources and have capability of producing large magnitude earthquakes. Historical and instrumental earthquakes clearly demonstrates the high seismic hazard in the region. The ancient city of Knidos at the Datça Peninsula was affected by the Rhodes earthquake of AD344 and the 1493 Kos event caused heavy damage in Bodrum peninsula. In the instrumental period, 23 April 1933 (Mw=6.5) Kos earthquake and 20 July 2017 (Mw=6.6) Bodrum-Kos earthquake caused damage throughout the peninsulas. With the aim of monitoring, collecting accurate and reliable data for engineering/scientific research purposes in particular to provide an input for future earthquake early warning implementation project on urban environments, two seismic networks consisting of nine strong-motion stations, were set up separately in June 2015 in Bodrum peninsula and in November 2018 in Datça peninsula. The former has five stations deployed in Bodrum and its subdistricts: Turgutreis, Yalıçiflik, Yalı-Çiftlik and Ortakent, and the latter includes four stations installed in Datça, Reşadiye, Karaköy and Kızlan. This paper introduces these seismic networks and future plans for further developments shall be presented. This study was supported by Boğaziçi University Research Fund Grant Numbers #10260 and #14509.

Keywords: Bodrum and Datça; strong ground motion; instrumentation
A case of active fault migration in Mygdonia basin, northern Greece

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This paper deals with the migration and evolution of part of the active boundary fault zone in Mygdonia basin. This basin is a roughly E-W to WNW-ESE trending asymmetric graben, bounded by two complex normal fault zones, the southern being more prominent than the northern one. It is associated with medium to large historical earthquakes, notably the 1978 M 6.5 destructive event. The basin bedrock consists of quartzites and quartzitic sandstones, with intercalations of dark grey phyllites, locally graphitic schists and dark grey psammitic limestone bands. The bedrock has been subjected to two different extensional phases since early Miocene, forming stratigraphic sequences of lacustrine and fluvial sediments. The study area is located at the SW boundary of the basin, in the broader area surrounding Lagyna village. The sedimentary cover in the area is a Pleistocene terrace system, consisting of gravels and sand. A large-scale mapping of the fault strands in the area showed that there are at least three sub parallel branches within the fault zone. They are all normal faults of NW-SE strike and dipping to the NE:

a) The first fault is the southernmost one and is located entirely within the bedrock. It appears as a series of shear zones, showing distributed deformation.

b) The middle strand defines the contact between the bedrock and the sedimentary sequence. It is the most prominent one, as it forms a clear fault scarp that dominates the morphology. It is the main active structure of the southern Mygdonia basin border and it is associated to the 1978 earthquake.

c) The northernmost branch is traceable within the Holocene sedimentary cover to the north of the main fault. It is visible in only a few places in and around Lagyna village, wherever a rigid structure is deformed (e.g. streets and roads, pavements, houses, etc.), as it appears as a set of predominantly open cracks that are aligned in the same direction as the two previous faults. This lineament is the youngest manifestation of the fault zone and, if not for the occurrence of man-made structures on it deformation zone, it would remain undetected.

A detailed morphotectonic analysis of the area, based on the SRTM 1-arcsecond Digital Elevation Model, shows that the two first fault strands affect the local drainage network, mainly its incision, but also the flow direction of the thalwegs. The third fault lineament has the weakest surface expression of all, as it is not noticeable in the analysis. The morphotectonic indices that were calculated for each of those faults indicate that the second one is the most active one. Nevertheless, it is certain that there are more branches of the fault zone that are located towards the center of the basin, as is shown by the aseismic deformation of the third strand, but also from the seismic surface ruptures of the 1978 event. This basinwards migration is a factor that is not considered when assessing the hazard, therefore it is of great importance to identify and model the secondary, yet younger, fault strands.

Keywords: Mygdonia basin; active faulting; deformation migration
The 141/142 A.D. Lycian earthquake: where and how?

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South-western Turkey is one of the tectonically active areas in the eastern Mediterranean region. The tectonic evolution of this region is dominated by westward motion of Anatolia, roll-back effect of the Hellenic Arc and the subduction transform edge propagator (STEP) fault zone. The Burdur-Fethiye Shear Zone is a transtensional zone between these tectonic structures on land and its offshore continuation to the southwest is the Pliny-Strabo Fault Zone. Both onshore and offshore faults are observed in this domain: oblique faults along the Burdur-Fethiye Shear Zone and thrust faults in the Mediterranean Sea. Most of these faults indicate recent earthquake activities. This region which consists of nearly 50 ancient cities is historically known as Lycia region. Most of the Lycian cities had been affected by many earthquakes and tsunamis throughout history. Considering the whole set of onshore and offshore faults, it appears that all of these faults caused damages in the ancient cities. Especially the 141/142 earthquake is one of the most destructive natural disasters in this region and caused heavy damage in 30 ancient cities. This study clarifies which fault is responsible for this earthquake and following tsunami event, and also points out what magnitude of an earthquake could be sufficient to cause such damage.

Keywords: Lycian cities; earthquake; tsunami; 141/142 A.D.
Scientific Session A.6

Marine Geology and Geophysics

Conveners:
Dr. Seda OKAY; Dr. Günay ÇIFÇİ;
Dr. Hülya KURT
Marine Gas Hydrates as Future Energy Source

Günay Çifçi, Mert Küçük, Özkan Özel, Orhan Atgın, Seda Okay, Seislab Group

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Continental slopes contain very big amounts of natural gas. In global scale, gases that trapped in iced like solids are several times larger than the gases in conventional accumulations. Systematical research studies revealed that, the gas hydrates that are accumulated in marine sediments in Japan waters are 90 times bigger than the national gas requirement of Japan. Nowadays the countries in South Eastern Asia (China, India, South Korea, Taiwan) and USA are investigating national gas hydrate reserves in their national waters. The successful tests of Japan in 2013 showed that natural gas can be produced from offshore gas hydrates. Common industry projects in Gulf of Mexico, onshore production in Canada and Alaska and in 2016 offshore production tests in South east Asia has delineated the gas hydrates as future energy source. The South China Sea is thought to contain some of the most promising deposits, and they promised to “actively develop” natural gas hydrate over the 2016-2020 five-year plan period. European seas except a few countries have not been investigated yet. In addition, geophysical data and numerical modeling show the existence of gas hydrates in Black Sea, North Sea, Mediterranean Sea and along Atlantic continental coasts. Europe would strongly benefit from the local gas hydrate reserves. The production of natural gas from gas hydrates improve supply security while reducing the future energy costs and lowering carbon dioxide emissions from fossil sources. Europe and our country should plan the gas hydrate researches and improve production technologies from gas hydrates.

Gas hydrates are found in Marmara Sea, Black Sea and the Mediterranean Sea at high pressures and low temperatures. The seismic Laboratory SeisLab which was established for gas hydrate researches at Institute of Marine Sciences and Technology has realised many studies between 2005-2018 to map gas hydrate areas and to take samples from seabed. In this process, multi-channel seismic reflection, multibeam, sparker, deep tow sonar and Chirp data acquired onboard R/V K.Piri Reis.

Keywords: Gas hydrates; energy; seismic reflection; natural gas
Synthesis of data sets recovered on the southwestern Black Sea shelf at the exit of Bosphorus and the evolution of depositional fan

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At the early 90’s mapping of the Northern Bosporus outlet on the Black Sea continental shelf gave clues about the processes and effects of the northward-flowing undercurrent out of the Bosphorus. This hypothetical catastrophic theory of a Mediterranean marine flood into the Black Sea led to stimulate research and led to important work recently published by researchers.

Here we propose a compilation of multibeam bathymetry data from previous studies together with high resolution chirp seismic data and gravity cores from southwestern Black Sea shelf acquired in 2002 on board Le Suriot, in 2004 onboard Marion Dufresne, in 2007 and 2008 on board R/V K.Piri Reis.

This work concentrates to describe a shallow fan system at the northern outlet of the Bosphorus Strait consisting of a main channel and short distributary branches, levees, and sediment waves. This shallow fan delta is in all points comparable to a depositional fan with a branching pattern of channels mimicking a mostly exposed fan-shaped body prograding from the foot of a significant break in slope and extending from the outlet of the strait to the shelf edge. This preserved fan on the shelf provides an important record of surface water flow at the Bosphorus outlet in SW Black Sea. Understanding how surface water flow could have produced the observed morphology is fundamental to understanding the history of the Marmara/Black Sea last connection with all the existing data. Geology and tectonics might have affected the shaping of its tributary channels.

Although we do not entirely resolve the ongoing controversies, we provide extra data to obtain a wider view to this key area. It is acceptable to propose that the distinct morphology of this form of fan delta could have been the result of a single event of basin-filling on a timescale of decades after a relatively strong Mediterranean-originated northerly flow into the partly subaerially exposed shelf area earlier than 8.5ky BP reshaped by present day saline undercurrent processes.

Keywords: shelf fan; Bosphorus; Black Sea; Mediterranean Sea; chirp seismic
A comparison of Danube River's water and sediment discharges with elemental data from a sediment core in Istanbul Strait's outlet area of the Black Sea

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A century-long water and suspended sediment load data of the Danube River correlates well with the sub-mm resolution µ-XRF elemental data of a radionuclide-dated core from the Istanbul Strait outlet area of the Black Sea. Danube River provides more than 50 % of the riverine water and sediment input in the Black Sea from its large catchment area in central and eastern Europe. The detrital proxy element (e.g. Ti, K) compositions of sediments from the southern margin of the Danube Delta and Istanbul Strait outlet area show similar temporal changes. This observation indicates the transport of sediments (and associated pollutants) from the Danube delta area to the southern Black Sea shelf and upper slope areas by the eastward-directed rim current. There is also a close correlation between Danube’s annual-multiannual flow rate and high resolution µ-XRF Sr and Ca profiles of the dated core. Considering that Sr and Ca in the Black Sea sediments are related mainly to the quantity of coccoliths produced by Coccolithophore, Emiliania huxleyi, this correlation indicates a connection between the riverine water input and Emiliania huxleyi blooms in the Black Sea.

This study was funded by TUBITAK project 114Y240 entitled “Effects of Danube basin related pollution at Black Sea sediment”.

Keywords: Regional characteristic elements; pollution; suspended material; reference data
The main purpose of this study was to investigate possible heavy mineral placers which could be of economic importance along the modern marine beaches of the Büyük Menderes River Delta (“BMRD”). During 1997, along a total of 33 km shorelines (incl. 23 km long delta shores) located between Doğanbey in the north and Mavişehir in the south were studied. 107 surficial (uppermost 5 cm) sediment samples were collected at foreshore, backshore and dune subenvironments. 44 sediment samples were chosen for geochemical analysis using ICP-ES method after dissolution of dry powdered samples with HF+HClO4+HNO3+HCl acid mixture. Various reference, standard materials and triplicate measurements were used to check accuracy and precision of the results. Although presented elsewhere, the BMRD sediments constituted largely fine sand (> 90%) whereas gravel, very coarse to coarse sand, medium sand and very fine sand together contained <10%. The total heavy mineral concentrations ranged from 1 to 24% (mostly 1-3%).

The concentrations of most elements were comparable with those from the crustal average and similar values were obtained from bulk sediments along and across the beaches. The somehow higher element contents were aligned to a couple samples where Fe (4.6%), Mn (1653 ppm), Ti (2.23%), P (0.33%) and Y (66 ppm) were measured. There was a positive correlation between these elements and total heavy mineral contents. This observation was further confirmed by the chemical analyses of heavy mineral fractions. These samples contained more element concentrations, such as Fe (10.7%), Mn (4336 ppm), Ti (3.13%), P (0.96%) and Y (178 ppm). Since heavy mineral fractions were found to relatively higher in all beach subenvironments, thus higher element concentrations were also measured in samples from all subenvironments. There existed positive and high to very high correlation coefficients ($r = 0.80-0.99$) among the elements which would suggest common sources and transport mechanisms suitable for the deposition of minerals of these elements. Further and more detailed studies, including mineralogical investigations are needed to provide reliable data for possible existence of beach placers along the BMRD beaches.

**Keywords:** Büyük Menderes; delta; heavy mineral
Application of 2D reflection tomography in the Gulf of İzmir

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Seismic velocity information plays a crucial role in understanding the subsurface geology. Volcanic rocks, salt domes are generally represented by high velocities while sedimentary rocks have comparably low velocities. The low-velocities in sedimentary basins may indicate economic resources. The most accurate and high-resolution velocity information can be derived directly from well measurements. However, well operations have high measurement costs. Seismic tomography method based on seismic reflection data can provide velocity information with less cost if there is no well already drilled in the study area. The seismic tomographic method may provide information also about attenuation, which is more sensitive to fluid changes. Attenuation information can be used to quantify saturation, porosity and permeability.

In our study area, there is Foça-1 well drilled by Turkish Petroleum in 1987. However, we do not have velocity measurements within this well. Reflection traveltime tomography performed on a multichannel seismic reflection data selected from the Gulf of İzmir to obtain a velocity-depth model of the study area for the first time. The time-migrated seismic section was interpreted stratigraphically before tomography application. Signal to noise (S/N) ratio was improved by performing preliminary data-processing steps such as noise elimination by editing, muting, notch filtering and spherical gain recovery. The purpose of this preliminary process is to better distinguish the hyperbolas associated with each interpreted horizons for the picking process. The interpreted horizons on the time-migrated seismic section picked on the common shot gathers. Then, an initial velocity depth model with a constant velocity and a flat interface were defined. A minimum-time ray tracing algorithm has been used to calculate the synthetic travel times and interface depth starting from the initial velocity-depth model. Synthetic travel times calculated by ray tracing were used during the travel time inversion adopting Simultaneous Iterative Reconstruction Technique (SIRT) to estimate the local interval velocities. The velocity distribution is updated by minimizing the travel time residuals. In each iteration, estimated interval velocity distribution was used to calculate the shape and depth of the interfaces in the study area.

The tomogram demonstrated the velocity-depth model of a sedimentary sequence of four seismic units (SSU1-SSU5) with a thickness of ~1 km offshore Foça that are separated by five interfaces (H1-H5). The interval velocities of the seismic units vary between 1.5-2.6 km/s. The acoustic basement displays a basin morphology that deepens to 800 m from west to east and shallow up to ~440 m in the east forming a ridge. The sedimentary units of the basin unconformably overly the basement.

Keywords: reflection tomography; traveltime inversion; minimum time ray tracing; simultaneous iterative reconstruction technique
High Resolution Seismic Evidence of Shallow Gas-Charged Sediments and Gas Escape Structures on Eastern Shelf of Saros Gulf, Northern Aegean Sea

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Shallow gas occurrences below the seafloor and dissolved gas seeps from the seabed in the eastern part of Gulf of Saros (GoS), north Aegean Sea, were investigated using data using multibeam bathymetry, high resolution chirp and sparker data collected during 2005 and 2011 cruises of the R/V Urania. Markers interrelated with gas and/or fluid outflow in the GoS are acoustic blanking, acoustic turbidity, enhanced reflections, pockmarks and seabed domes. The anomalous gas points to four main areas. These, from east to west, are: a) gassy sediments with acoustic blanking and quasi periodic pockmarks observed in a depocenter offshore of Kavak River mouth, b) Gassy deltaic sediments and/or methane derived carbonate mounds observed with acoustic blanking accompanying buried pockmarks on the northern side of Ganos-Saros Segment. Deep seated faults observed in this part also seem to have assisted upward migration of the gas, c) Bottom acoustic turbidity and enhanced reflections at the southern margin of the Saros Shelf bounded by oblique trending faults, which in certain locations suggest the presence of specific gas plumes and accompanying acoustic blanking in chirp data and bright spots in sparker data (e.g. off Güneyli Bay), and d) Conspicuous acoustic turbidity inside highly inclined oblique progradational echo types north of the Saros Fault, within the offshore route from Gökçetepe to Mecidiye frontier in the northwest part of the study area, where impressions of gas trapped in the shallow interior of the shelf - edge delta is observed. Chirp profiles show small scale folds and fluctuations in prograding delta deposits, towards the main deformation axis, which may have imprint of progressive creep arising from transtension. There are some seismic reflection markers related to gas venting into the water column on the active fault plane. Transparent gas columns and low amplitude sediment packages can directly be seen very close to a push up structure in the valley, which gradually lose their expression further away from this morphological uplift. A remarkable feature in this study is the expulsion of gas identified on the seismic profiles which starts just before the last lineament forming a mini sub-basin, and ending at the toe of the slope in the shelf. This structural rupture is inferred to be a gas/fluid pathway (like gas blowouts) in a narrow zone of weakness with soft sediment deformation along with mud volcanoes/diapirs and pockmarks.

Keywords: Gulf of Saros; shallow gas; high resolution seismic reflection; creep
Lake Sapanca is situated in the northwest Turkey between Izmit in the west and Sakarya in the east in the eastern Marmara region. The lake is a basin created by faulting and is located on the northern strand of the western part of the North Anatolian Fault Zone (NAFZ). NAFZ is tectonically complex zone which is well-reflected by the neighboring morphology consisting of a series of fault-generated mountain ranges defining the boundaries of the lake. The NAFZ, one of the most seismically active fault zones in the world, is 1600 m long and the most important element that governs the recent tectonic and morphologic development of the northern part of Turkey with its dextral strike-slip characteristic. The northern strand of NAFZ contains the segments which slipped during the 17 August 1999 Kocaeli earthquake of which the surface rupture passes through Lake Sapanca. Previous researchers studying Lake Sapanca’s submarine tectonic characteristics mainly describe the lake as a pull-apart basin and the North Anatolian Fault (NAF) yielding a pull-apart and/or step-over fault geometry based only on the bathymetric data collected before and right after the 17 August 1999 Kocaeli earthquake.

In this study, multibeam bathymetric and high-resolution boomer-sourced sub-bottom profiling data collected in the scope of TÜBİTAK-1001 project (Project No: 117Y130) were used to determine the characteristics of the active submarine tectonism in Lake Sapanca. Sub-bottom profiling (SBP) is a type of seismic reflection method which is used for shallow seismic reflection profiling operating at broader range of frequencies. The SBP data of Lake Sapanca processing was carried out in Nezihi Canitez Data Processing Laboratory of Department of Geophysical Engineering, Istanbul Technical University. In the processed seismic sections, the NAF reveals itself as a vertical discontinuity creating a small-scale folding on the lake-bottom as well as sedimentary misalignments as it extends deeper. All discontinuities interpreted as the NAF traced from SBP sections can also be associated with the lineaments observed on the multibeam bathymetric image. Examining the fault map produced, the NAF can be traced along Lake Sapanca as it enters from the south west corner of the lake and lengthens approximately 5 km towards the middle section of the lake with W-NW direction making an approximately 30° angle to the map plane. The fault slightly changes its direction towards the west as it continues almost straight for another 5 km until it leaves the lake at the North West corner. This fault geometry of the NAF indicates the fault has evolved with releasing bend characteristics in Lake Sapanca.

Keywords: Lake Sapanca; North Anatolian Fault; sub-bottom profiling; multibeam bathymetry
Automated seismic interpretation using edge detection techniques

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A digital image described in a 2D discrete space is derived from an analogue image in a 2D continuous space through a sampling process that is frequently referred to as digitization. The edges in an image keep too much information. The edges tell where the objects are, give information about their shape and size, and something about their texture. An edge is where the intensity of an image moves from a low value to a high value or vice versa. Edge provides a number of derivative estimators, each of which implements one of the definitions that the first derivative of the intensity should be larger in magnitude than some threshold and places where the second derivative of the intensity should have a zero-crossing. For some of these estimators, it could be specified whether the operation should be sensitive to horizontal or vertical edges, or both. Edge returns a binary image containing 1's where edges are found and 0's elsewhere. In this study, basic definitions of image processing, applications of image processing in geophysics, edge detection techniques are investigated and practices were carried out on some regular images and seismic reflection cross-sections, using both selected and automatically calculated threshold values. For this purpose, a MATLAB based software was prepared for detecting edges on seismic images. The code was used for determining the vertical and horizontal edges respectively. It is determined that edge detection operators like Canny, Sobel and Prewitt can provide very valuable information about the geological structures which are sometimes hard to define on the seismic cross sections.

Keywords: edge detection; interpretation; seismic reflection
Temporal gravity variations and its relation to seismic activities in some active areas in Egypt

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Recent crustal deformations studies in Egypt are applied on the most active areas with relation to seismic activity. The area around the high Dam Lake, Aswan, the Southern part of Gulf of Suez and the area around Cairo (Greater Cairo) are considered to be the areas of considerable seismic hazards. Abou Elenean et al., 2009 outlined the main tectonic trends and the seismicity of Egypt. Here the areas around the High Dam Lake and Greater Cairo are presented as case studies. Temporal gravity variations in parallel with the geodetic technique (GPS) had been used to monitor recent crustal movements in Egypt since 1997. The geodetic network around the High Dam, Aswan, was the first net to be measured in Egypt. The non-tidal gravity changes were constrained by the vertical component of surface movements derived from the GPS observations. The trend of gravity changes indicated a positive stress south of the Kalabsha fault in combination with expected lake water penetration into the Nubian sandstone; the lowest gravity changes along the Kalabsha fault reflect the strike component of the stress field. Recently the correlations between the seismicity, gravity variation and water level of the lake are performed reflecting a considerable relation till 2018.

The second case study is the area around Greater Cairo. The temporal gravity variations were used to understand the surface tectonics and geodynamic modelling after the occurrence of an earthquake of 1992. More, than five successive gravity measurement campaigns were performed in parallel with the GPS observations. The gravity changes were determined and correlated with seismic activities. It was found that there is a certain relation shown by increasing of gravity values before the main seismic activity. As example, a relative considerable increase of gravity values was noticed for the network between the epochs of 2000 and 2004. Otherwise, the temporal gravity variations were reported a considerable decrease in gravity values between the two campaigns of 2004 and 2007 for the same stations. This behaviour could explain by compressive deformation and strain build-up stage before the South western Cairo earthquake (July 31, 2005 with magnitude of 4.3) and the stress release stage occurred after the main event. In additions, the results of geodetic measurements of the network around Cairo after five campaigns showed that, the estimated horizontal velocities for almost of points are 5.5 mm/year in approximately NW direction.
2D, 3D structure boundaries of the tectonic compositions of the Anatolia and the surrounding seas with the utilization of Gravity (satellite) data

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MTA Deniz Araştırmaları Daire Başkanlığı, ANKARA

The satellite gravity data can be examined with the arrangement of the density of the data for the problems of the earth structures in order to solve detail, semi-detail and regional problems. Here, the linearity of the gravity data was examined in terms of large wavelength structures in plate size in 2d and 3d.

2d curvatures identify important stress areas but provide the Cartesian boundaries for the spatial distribution of the source effect. Due to grid formation, these boundaries are affected at different rates from less dense and very dense structures. However, the main determinant is the geometry of the structures.

Different wavelengths in structure boundary analysis are the derivative and phase elements and filters. In 3d analysis, vertical change can be made at the approach level with analytical examination of 2d change. The distribution of the source effect determines the depth, model and structure parameters. When examining large wavelength structures, the gravity effect of some of the structures beneath the surface is covered by dense structures by the data.

3d building solutions are important in this respect. In search of solutions for tectonic structures that we may miss; The tectonic components that need to be confirmed in the Eastern Mediterranean have been tried to be elucidated in this study.

Keywords: Gravity; Filter; Moho; longwavelength; 2D; 3D Inversion
Scientific Session A.7

Paleomagnetic Investigations & Reconstruction Studies

Conveners:
Dr. Nuretdin KAYMAKÇI; Dr. Mualla CENGİZ ÇİNKU;
Dr. Orhan TATAR; Dr. Mümtdaz HİSARLI
Preliminary Paleomagnetic Data from the Interaction Area of North Anatolian and İzmir-Balikesir Transfer Zones

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The unique position of western Anatolia in the African-European convergent tectonic setting has resulted in a complex deformation history with several large-scale tectonic features. The region is dominated by NNE directed extensional deformation since the late Eocene. This extension has resulted in two large-scale tectonic domains, the Cycladic (CCC) and Menderes (MCC) metamorphic core complexes. Recent studies have shown that these two domains are linked with a major structure, the İzmir-Balikesir Transfer Zone (İBTZ), which is an accommodation structure that transfers differential extensional strain between these extensional domains. It is believed that the İBTZ is a relict or reactivated old structure that played an important role in the development of the Menderes and Cycladic Core complexes and it also interacted with the southern branches of the North Anatolian Fault Zone (NAFZ).

We employ paleomagnetic and fault kinematic studies in order to investigate the role of the İBTZ in the development of these core complexes and its interaction with the NAFZ. So far, we have already accumulated a very large data set that combines available literature data and newly acquired paleomagnetic and fault kinematic data, integration of which will be used to unravel the tectonic development and evolution of the region.

The preliminary results show that western Anatolia has experienced (at least) two separate rotational phases since the Miocene. During the first phase, deformation within the İBTZ was dominated by transcurrent tectonics and associated block rotations as high as 50° clockwise, while the MCC has rotated in a counterclockwise sense. Contemporaneously, the İBTZ evolved as a wide shear zone and accommodated differential extensional exhumation of the MCC and the CCC along detachment faults. During the second phase, the mode of extension switched from distributed diffuse deformation to discrete local deformation, possibly due to tearing of the northward subducting African oceanic slab along the Pliny-Strabo Trenches. This is manifested on the surface by narrowing of the İBTZ, resulting in decoupling of normal and strike-slip faults. During this period, the MCC experienced slight clockwise deformation, while the block including “localized” İBTZ has experienced about 25° counter-clockwise rotation. This study is supported by a Tübitak Project (Grant No: 117R011).

**Keywords:** paleomagnetism; block rotation; late Cenozoic; İzmir-Balikesir Transfer Zone; western Anatolia.
Revealing Plio-Pleistocene Terrestrial-Marine Environmental Transitions in Southwestern Anatolia by Using Magnetostratigraphy: Obtained Results from Daçta, Söke, Germencik

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Plio-Quaternary terrestrial and marine sediments deposited in the coast of Southwestern Anatolia, structural data collected from those sediments, and integrated stratigraphic studies including magnetostratigraphy conducted to reveal the sea level changes and its relation to global tectonism are the subject of this study. Daçta, Bodrum, Söke and Germencik areas are selected in the scope of this study. In this presentation, the first correlation models prepared by using magnetostratigraphic sections in Daçta, Söke and Germencik areas will be discussed.

In the scope of this work, magnetostratigraphic samples were collected from the sites which includes sedimentary rocks deposited in Plio-Pleistocene time interval. Samples were taken through three different stratigraphic section from Yıldırımlı Formation cropped out in Daçta region, and in total 344 magnetostratigraphic samples were collected from 102 stratigraphic levels. In Söke region, samples were collected from Fevzipaşa Formation, and in total 131 magnetostratigraphic sample were collected from 44 stratigraphic levels. In Germencik region, 63 magnetostratigraphic sample were collected from 20 stratigraphic levels of Hıdırbeylı Formation. The paleomagnetic analysis of those samples is conducted in Fort Hoofddijk Paleomagnetism Laboratory, University of Utrecht. As a result of analyses, obtained magnetostratigraphic sections are compared to the Global Polarity Time scale (GPTS), and for all regions the obtained results were compared in accordance with the obtained age results.

This research is supported by TUBITAK (The Scientific and Technological Research Council of Turkey) –Grant Number: 117R012.

Keywords: magnetostratigraphy; Yıldırımlı Formation; Fevzipaşa Formation; Hıdırbeylı Formation; Southwestern Turkey; global polarity time scale
Paleomagnetism of the Karhova Triple Junction and surrounding area, Eastern Anatolia.

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Oceanic lithosphere beneath southern Neotethys Ocean got totally consumed after the collision between the Arabian and the Eurasian plates started at around 15 Ma. Anatolian plate began to move westward, along the sinistral East Anatolian Fault Zone (EAFZ) and dextral North Anatolian Fault Zone (NAFZ). In the 10 km northeast of Karhova, NAFZ and EAFZ meet with the Varto Fault Zone (VFZ) and form a triple junction. This tectonic unit is named Karhova Triple Junction (KTJ) and characterised by transtensional tectonics. VFZ begins at the KTJ in the west and continues NW-SE trending with a length of about 30 km along and maximum width 12 km. VFZ is divided into three segments from north to south; Varto, Leylekdag and Çayçatı respectively. Several models have been proposed to explain the mechanical behavior and/or initiation of VFZ. These models for the region and the results obtained from this study were compared and valuable information was presented to the literature.

Oriented palaeomagnetic core samples were collected at 16 sites in the Karhova - Varto region and 8 sites in the vicinity of the Solhan from Pliocene aged volcanics. Also samples from the 19 sites were collected from Miocene - Pleistocene aged volcanics, near the Tunceli - Elazığ provinces. Paleomagnetic samples were collected using a portable motorised core drill and orientations were determined using both magnetic and sun compasses. Paleomagnetic laboratory studies were carried out in the KANTEK Paleomagnetism Laboratory. Standard paleomagnetic demagnetisation tests have been applied to all of the samples. Only one paleomagnetic site has unreliable magnetisation direction. Therefore a high percentage of paleomagnetic sites have reliable remanent magnetisation. Our results indicate that western part of the VFZ has rotated counterclockwise (~22±13°) and eastern part has rotated clockwise (~22±11°) relative to the predicted field direction at this location in Pliocene times. Also, there may have been a change in the tectonism of the Tunceli-Elazığ region between Miocene and Pleistocene, because younger Pleistocene volcanics are rotated counterclockwise, while there are not any rotation observed in the Miocene volcanics.

This study was financially supported by the Scientific and Technological Research Council of Turkey (TUBITAK-115Y208) and Scientific Research Projects of Istanbul Technical University (BAP-38661).

Keywords: paleomagnetism; Eastern Anatolia; neotectonics; Karhova Triple Junction; Varto Fault Zone
Paleomagnetic Investigations & Reconstruction Studies
International Earth Science Colloquium on the Aegean Region, IESCA-2019, Izmir, Turkey

A7-4

Paleomagnetism of the Tunceli – Elazığ Province, Eastern Anatolia

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Due to the compressional tectonic regime in the Eastern Anatolia region after the northern motion of the Arabian plate, Anatolian plate started to move westward along the North Anatolian Fault Zone (NAFZ) and East Anatolian Fault Zone (EAFZ). NAFZ and EAFZ meet at the 10 km northeast of the Karlıova and make a junction with the Varto Fault Zone. Tunceli - Elazığ province is located at the west of the Karlıova Triple Junction, on the Anatolian plate.

Paleomagnetic samples from 19 sites were collected from the Miocene - Pleistocene volcanic rocks to determine the tectonic evolution of the Tunceli - Elazığ province. 4 of the 19 paleomagnetic sites were collected from Pleistocene and the other sites were Miocene volcanic rocks. Typical paleomagnetic cylindrical cores were drilled using a portable petrol-powered motorised drill with water-cooled, diamond-coated and non-magnetic drill bits. Orientations of these cores were determined using both magnetic and sun compasses. Paleomagnetic laboratory studies have been done in the KANTEK Paleomagnetism Laboratory. Standard paleomagnetic demagnetization tests have been applied to all of the samples. Demagnetization steps of paleomagnetic samples are shown on Zijderveld and Stereographic projections.

Paleomagnetic results indicate that a counterclockwise rotation of 28° is observed in the Pleistocene rocks to the south of the study area. Miocene volcanic rocks show 6° net clockwise rotation. Also, different rotations are observed in the Miocene rocks in the study area. For example, most of the Miocene rocks do not show any rotation. While only two sites show counterclockwise rotations. This observation may be interpreted as a tectonic boundary both sides of this site showing the counterclockwise rotation. The difference in paleomagnetic rotations of Miocene and Pleistocene volcanics indicates a change in tectonic regime.

This study was supported by the Scientific and Technological Research Council of Turkey (TUBİTAK-115Y208) and Scientific Research Projects of Istanbul Technical University (BAP-38661).

Keywords: paleomagnetism; Anatolian Plate; Karlıova Triple Junction; Tunceli –Elazığ Province
Scientific Session A.8

Quaternary Events & Climate Change Records across the Eastern Mediterranean Region

Conveners:
Dr. Darrel MADDY; Dr. Ökmen SÜMER;
Dr. M. Akif SARIKAYA; Dr. Sezgül KAYSERİ-ÖZER
The Largest (?) volcanic eruption from South Aegean Volcanic Province: It’s footprints in Western Anatolia

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Quaternary volcanism is widespread, especially in the central and eastern Mediterranean. One of the most important volcanic areas in this region is the South Aegean Volcanic Province (SAVP) which is formed as a consequence of the northward subduction of the African plate beneath the Aegean-Anatolian microplate along the Himalayan-Alpine mountain belt. SAVP consists of volcanic islands, composed of volcanic rocks with calc-alkaline geochemical characters. These volcanoes are represented by quite large eruptive volcanoes. In this context, for the last 100 ka period distal tephra layers is a highly studied topic on deep-sea core in the Aegean and Mediterranean seas, as well as the western Anatolian mainland. However, while the scientific data from these studies focused on the Minoan eruption of Santorini, the products of older volcanic eruptions of 1-2 Ma have not been studied in detail in Western Anatolia within the scope of the SAVP. This study concentrates on recently discovered air-fall ash deposits in the Pleistocene continental to marine sequences in the Söke and Germencik areas which are located at the western termination of Western Anatolia and is focused on their possible source.

In Söke area two layers (Upper ash-fall layer; UASH and Lower ash-fall layer; LASH) occur, however in Germencik area only LASH has been identified. LASH coincides with the boundary between the lower and middle parts of the Fevzipaşa Formation, and the upper ash layer found between the middle and upper parts of the formation. These are whitish beige, fine-grained, pumice and biotite-bearing layers. In Söke and Germencik areas, thickness of the LASH ranges between 12 - 16 cm and 10 -12 cm respectively, but UASH exposed in Söke 14 - 20 cm thick. 2σ corrected biotite and groundmass K/Ar ages of the LASH varies between 2.4±0.3 and 2.15±0.10 Ma, whilst the UASH between 1.18±0.13 and 0.95±0.15 Ma, confirming their stratigraphic positions. SiO₂ and TiO₂ contents of the samples vary between 60.0% and 70.2% and 0.14% and 0.47%, respectively. (K₂O + Na₂O) / (K₂O + Na₂O+CaO) ratios of the samples change from 0.65 to 0.84. The samples are classified as high-Si andesite and mostly rhyodacite and rhyolite. La/Yb ratios vary between 18.3 and 30.3. Nb/Zr (0.09 - 0.132), Nb/Rb (0.11 – 0.18), and Ta/Rb (0.010 - 0.019), and Zr concentrations (80.0 - 134.3 ppm) reveal that the these volcanic ash deposits originated from SAVP, most likely from Milos eruption. Furthermore, on the basis of thickness variation and volcanic center distance probabilistic modeling of tephra dispersal analysis, it is suggested that these eruptions of Milos were larger than the Santorini Minoan eruptions. It is speculated that the UASH may represent the largest eruption in the SAVP, which has not been reported until now.

Keywords: Volcanic eruption; air-fall ash layers; Western Anatolia; Pleistocene
Scientific Session A.9

Geoarcheology & Geological Heritage in Anatolia and Beyond

Conveners:
Dr. Ökmen SÜMER; Dr. Nizamettin KAZANCI;
Dr. Akın ERSOY; Dr. Mahmut DRAHOR
The present study deals with the use of Cathodoluminescence Microscopy (CL) for the archaeometric study of a Roman-Late Roman ceramic assemblage collected during the archaeological surface survey in Sphakia area, SW Crete, Greece.

In archaeometric studies, sometimes the very small size of the ceramics samples inhibits the use of multiple destructive techniques, such as chemical analysis or thin sectioning. For this reason the use of cathodoluminescence could be a useful tool for a first approximation of the compositional variability of the ancient ceramics and their preliminary screening in relevant groups. This approach will subsequently guide the sampling strategy which can be performed in a more representative way, capturing the compositional variability of the assemblage.

In the present study, a subset of representative sherds in terms of their typology was examined under cathodoluminescence microscopy (CL), aiming to identify the composition of the clay matrix, the minerals and the lithological components, which, mainly due to their fine size, could not be determined safely through optical microscopy. Cathodoluminescence contributed to the identification of compositional discrepancies among the studied samples, whereas their examination through SEM-EDS further confirmed these results. Optical microscopy provided only abstract evidence of the clay matrix composition, due to the very fine particle size.

CL results revealed two groups (calcareous and a non-calcareous group), based upon the calcite presence testified by its orange luminescent colour. The results from SEM-EDS confirmed this grouping, since the obtained microanalyses showed the same differentiation concerning the bulk calcium oxide content. The results obtained highlight the use of cathodoluminescence as a considerable non-destructive and low cost method for the compositional characterization of ceramic artifacts.

Keywords: cathodoluminescence; archaeometry; Sphakia
New Geosite Candidates from Urla (İzmir, Western Anatolia, Turkey): A list of Geological Assets Nested with the Antique and Modern Cultural Heritage

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The Urla Basin is a N-S-trending strike-slip basin, approximately 20 km wide and 30 km long, which is located at the westernmost part of the Western Anatolia Extensional Province. Although the basin-fill units are generally composed of sedimentary and volcanic rocks of Miocene to recent, Triassic and Late Cretaceous-Plaecocene sedimentary rocks are also exposed in the middle and western part of the basin. In addition to this geological diversity, the basin hosts many ancient settlements due to its geographical position and close contact with the Aegean Sea. This study mostly focuses on the northern part of the basin with a focus on the possible geological heritage sites from the Urla and surroundings and its cultural heritage assets. Klazomenai and Liman Tepe, one of the best examples archaeological sites in the area, have a respectable scientific importance. Some other cultural heritage assets are also very important, such as Yıldız Tepe Martyrdom Monument, Karantina Island, traditional Vineyards of Urla, Urla Art Street and fellow-townships of some well-known figures of literature and popular culture such as Yorgo Seferis, Necati Cumalı and Tanju Okan. We present seven new geosite candidates, which are considered in the geological framework category groups B, C and E of the Geosite Framework List for Turkey. These sites have quite important geological meaning and value for the earth science education.

Keywords: candidate geosites; Cultural Heritage Assets; Urla Basin; Western Anatolia
Travertine Spring Towers as Rare Depositional Morphologies in Geothermal Fields: An Example from the Hisaralan Geothermal Area (Sındırgı, Balıkesir, NW Turkey)

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The hot springs of the Hisaralan geothermal site, located 25 km NE of the Sındırgı town, Balıkesir, in NW Turkey, on a SW facing slope, have led to arise spectacular travertine landscapes that are characterized by the unusual spring towers and other depositional morphologies such as spring mound, slope, waterfall and fissure ridge. The oldest rock unit in the area is the Bornova Flysch. They are covered by the Miocene volcanic rocks such as dacite – rhyodacite. The hot springs oversaturated with respect to calcite and aragonite and their temperatures range from 55 to 99°C. About 60 spring towers were recognised in the study area, some of them reach up to 5 m in height. Presently, the towers are mostly inactive, however, several ones are still active along the Serin stream to the west of the study area. The active towers are formed by the artesian springs. Currently, the spring area and hot waters are being used inappropriately for mainly greenhouse and domestic heating by the local people. Consequently, the Hisaralan geothermal site needs urgently protection and a proper management. After this study, the Hisaralan geothermal field was proposed to the goverment as a potential geopark to be established in NW Turkey.

The results presented in this article are part of a project (no. 115Y141) supported financially by The Scientific and Technological Research Council of Turkey - TÜBİTAK.

Keywords: travertine spring tower; geoheritage; Hisaralan
The Biga Peninsula to the South of Dardanelles (North West Anatolia) well known for its numerous archeological harbor-cities. The oldest is considered to be Troia (about 3000 B.C.) with its legendary wars between Akhai and Troians (about 1900-1050 BC). Alexandreia Troas and Assos located to the South of Troia are the other two important harbors of the area. Assos was also a well-known meeting place for philosophers such as Theophrastus, Dioskurides and Aristotle, who was one of the greatest philosophers of the world, worked and lived in the town for three years in the gymnasium at Assos. It is also said that sarcophagus (?) or otherwise called “Asian Stone” (?) to have been found at Assos and to be widely traded from its harbor reaching as far as Rome and Egypt. The stone was believed to decompose the corpses placed in the sarcophagus within a short period; therefore, the word itself meant “flesh eater” Σαρξ (σαρκος) in Greek, thus also indicating that the name sarcophagus for the tombs originated in Assos. Religiously it was important, since it was thought that one could reach heaven easier and faster, because of earliest decomposition. German philologist of classical languages Konrad Gaisser in his book “Theophrast in Assos” (1985) tries to answer this question by exploring available documents of ancient philosophers and consulting professor W. v. Engelhardt, Director of the Institute of Mineralogy from the University of Tübingen, Germany (my teacher). The writer found out that many ancient philosophers agree “Asian Stone” (?) to be a good medicine to dry out wounds or cure such inflammation as gout, is not hard and easy to break, tasting like a salt and with a white powder on a surface. All these characteristics indicate “Asian Stone” to be alunite. In contrast to “Asian Stone” of Assos, sarcophagus, made from trachyte, which is hard, resistant without any alteration or weathering, and still well preserved. So, the question is why did they use another name for the stone? Prof. W. v. Engelhardt, after analyzing the geological map of the area, suggested that Assos, situating on the volcanic rocks, might contain small veins of alunite. If alunite is in a closed system and affected by moisture, it transforms into sulphate, which is a good condition for body decomposition. We found out that Assos is located on the hard trachyte rocks, without alunite veins. However, after further investigations we discovered unknown ancient mining areas in three villages situated to North and North West of Assos. The main composition of the mines was alunite, impregnated within the altered tuffs and other magmatic rocks. We found out some relict, hard and fresh parts of altered tuffs within the sarcophagus, originated from the above-mentioned alunite mines. It means “Asian Stone” (alunite bearing tuffs) was additionally put into sarcophagus for the faster decomposition of flesh.

Keywords: “Flesh eater”; Sarcophagus; alunite; Assos
Western Turkey Delta Developments and Their Effects on the World Civilization and Consequences

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The Aegean is the sea that is surrounded between the coasts of mainland Greece, the coasts of western Turkey and Crete. The current geomorphological condition of the Aegean is the result of three main parameters: the tectonism, the volcanic activity and the eustatism (i.e. the rise and fall of the sea level). The broad shelves occur predominantly along the eastern and northern Aegean Sea. Except for the outlet of the Dardanelles, all are found seaward of major present-day deltas. The shelf-break in broad shelves occurs between 95 and 120 m water depth and denotes the topset to foreset transitions of deltas prograded during the end of last glacial period (at 12 ka and reached to an optimum level at around 6 ka), immediately prior to Holocene transgression. Büyük Menderes, Küçük Menderes, Gediz, Bakırçay and Karamenderes are the important delta plains and they have significant effects on geomorphologic changes during the geological period in western Aegean Shoreline. On these deltas there are ancient towns such as: from south to north, Miletus, Ephesus, Smyrna, Pergamum and Troia. All of these towns were started about 6 ka after the formation of the deltas same as the development of Nile Delta, Mesopotamia, Indus Delta and Gange Delta. All the important geomorphological and town names were given by the Luwians who were the occupants of the Anatolia before the states named Hittite, Phrygia, Lydia etc. The Luwian language is Proto-Turkish.

Keywords: Aegean deltas; antique towns; Luwis
Possibly the first pyrotechnology application on walls of a rock-cut dwelling in Central Anatolia, Turkey

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Thee Mahkemağın Underground City (MUC) located at the Kızılcahasamam area of northern central Anatolia, Turkey is a four-floored settlement hosted in tuffs of Early-Middle Miocene, a part the Köroğlu volcanics in the Galatia Volcanic province. Presently it has been overlain by the modern Mahkemağın village as modern example of successive settlements called höyük in Anatolia. The most significant difference of this settlement from similar ones in Cappadocia, central and eastern Turkey is presence of a 1-6 cm thick crust on walls of the city. The topic of this presentation is to introduce the MUC and to analyse the mentioned crust when and what for was formed.

To archaeological references the Kızılcahasamam region had been occupied by Phrygians (1200-550 BC), Persian (550-334 BC), Galatian (277-25 BC), Rome and Byzantine (ca 25 BC-1000 AD). In addition, the Galatian language (Celtic) had been lived here until end of VI the century. However, there is no solid information about the Mahkemağın ground city when it was constructed. By analogy and based on presence of holly crosses, it is suggested that city was carved and used first by Phrygians and then by Galatians. Fresh surfaces of tuff exposures are not resistant to erosion, however lichens and herbal plants conserve the tuffs relatively. On the other the crust is highly hard and it cannot be broken unless hammering. In this study the crust and host tuffs have been examined by strength test, thin section, XRD, XRF and electron microscopy. A heating test was also performed using host rock samples The aim was to detect and compare mechanic properties of both crust, heated samples and tuffs. Results indicated that there were significant physical and mechanic differences between heated and host rock tuffs. Based on analytical data we interpreted that the crust was created liberately by heating in order to preserve walls against to peeling or erosion. This must be the first application of pyrotechnology in Anatolia. As holly crosses were covered by the crust, the thermal operation in the city was likely to have been applied in early Byzantine period by Galatians.

Keywords: anthropogenic crust; pyrotechnology; Galatia
Scientific Session B.1

Metallic Deposits in the Mediterranean Region

Conveners:
Dr. İlkay KUŞÇU; Dr. Tolga OYMAN
Application of elemental and isotopic studies as a tool for ore exploration

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In this study the combined Electron Paramagnetic Resonance Spectroscopy responses and geochemical characteristics of carbonate samples can be used as an exploration tools in any mine areas. The EPR intensity of dolomite samples were measured based on the peak height of Mn\textsuperscript{2+} sextets. The EPR intensity values are very low (average 5cm) in least-altered samples, while the highest EPR peak height (Average 17cm), occur in the highly altered samples close to the mineralized area. Bivariate plots of EPR intensity versus Mn and Fe and also oxygen isotope values of least and highly altered samples can be used as evidence for hydrothermal alteration in carbonates. The highly altered samples with high Mn (2790ppm) and Fe (18657ppm) contents and light oxygen isotope values (average -8 per mil VPDB) indicate that these samples are very close to the ore body and thus effected by extensive hydrothermal alteration. Thus, the results of this study are encouraging for further study.
Zajkan intermediate-sulfidation epithermal deposit, NW Iran: Mineral paragenesis, fluid inclusion and oxygen-sulfur isotope

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Zajkan is a small (0.2 Mt) epithermal base metal deposit in the Tarom-Hashtjin metallogenic belt (THMB), northwestern Iran. It occurs as quartz-base metal sulfide veins hosted by Eocene volcanic and volcanioclastic rocks of the Karaj Formation. Four stages of ore formation are identified at Zajkan: (1) quartz-chalcopyrite-pyrite veins, (2) quartz-galena-sphalerite ± chalcopyrite ± pyrite veins and breccias, (3) quartz-hematite veins and breccias, and (4) barren quartz-carbonate veinlets. Microthermometric measurements of primary LV fluid inclusion assemblages in quartz and sphalerite indicate that the veins were formed at temperatures between 217 and 273°C from fluids with salinities between 1.7 and 6.4 wt.% NaCl equiv. The oxygen isotopic compositions (δ18Owater of +3.7 to +1.1‰) indicate that the ore-forming fluids were mainly derived from magmatic water with the input of meteoric water in the later ore-stages. Sulfur isotopic values of sulfide minerals vary over a narrow range from −5.0 to −0.9‰ (averaging −2.2‰), suggesting that sulfur was derived from a homogeneous magmatic source. The fluid inclusion and stable isotope data indicate that fluid boiling and mixing facilitated hydrothermal alteration and mineralization at Zajkan. Our data suggest that the Zajkan deposit is an intermediate-sulfidation style epithermal mineralization.

Keywords: fluid inclusion; stable isotopes; Zajkan
B.1. Metallic Deposits in the Mediterranean Region
International Earth Science Colloquium on the Aegean Region, IESCA-2019, Izmir, Turkey

B1-3

Copper and iron isotope geochemistry of the mineralization in the NE of Yenice (Çanakkale-Biga Peninsula), NW Turkey

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In the east of Çanakkale (NW Turkey), porphyry-skarn-epithermal ore systems occur the northeast of Yenice. The hydrothermal mineralization in Yenice is related to Oligocene magmatism associated with collisional and post-collisional tectonics. Mineralization in the studied area displays a large variety of hydrothermal systems including Soğucak Cu-Mo porphyry and associated Fe±Cu skarn, Alandere distal Pb-Zn-Cu skarn and epithermal veins (e.g. Arapuçandere, Kozcağız, and Sofular). The Cu and Fe isotope analysis have been applied to understand the nature of metal transport and to distinguish the source of hydrothermal solutions in the mineralization systems.

The Cu and Fe isotope fractionation were measured from pyrite and chalcopyrite separates, the most common sulfides associated with ore paragenesis within hydrothermal systems in the area. In the northeast of Yenice, quartz-dominated veinlets of molybdenite-pyrite-chalcopyrite are hosted by the porphyritic subvolcanic Soğucak porphyry and occur in phyllic and propylitic to alteration assemblages. The lighter Cu isotope composition (δ65Cu=0.13‰) is obtained from the inner propylitic alteration and the heavier values are observed in the phyllic alteration and the skarn. By contrast, Fe isotope fractionation shows a progression from heavier isotopic compositions in the porphyry to the lighter isotopic composition in the skarn mineralization.

The Arapuçandere Pb-Zn-Cu (Ag-Au) deposit is one of the most important epithermal deposit with two economically mineralized veins in the Yenice region. Samples were taken vertically and horizontally among the 308, 200 and 160 mine levels from the underground that intersect the veins from different directions and elevations. In deeper levels of Arapuçandere deposit, the early stage hydrothermal pyrite is enriched by lighter Fe isotopes, whereas the heavier Fe isotope compositions are observed towards shallower levels of the veins which reach up to δ57Fe (δ56Fe) -0.63‰ (-0.43‰). Likewise, the Cu isotope values from the deposit tend to be progressively heavier through the surface, with the exception of two samples from 160 and 200 mine levels. The Cu and Fe fractionations in Arapuçandere deposit is thought to be caused by temperature and phase change due to the boiling and mixing of the ore-forming hydrothermal fluids through time and space.

The surface samples from other veins (i.e., Kozcağız and Alandere) show lighter Cu and Fe isotope compositions in relatively distal parts of the flow paths from the magmatic systems in the area. The Cu-rich mineralized quartz veinlets in Sofular intrusion has similar Cu isotope composition to those of the Kozcağız and Alandere epithermal veins. However, its Fe isotopic composition is heavier, indicating a significant iron involvement from a magmatic source.

Importantly, the Cu and Fe isotope studies on different types of mineralization in the northeast of Yenice show fractionation processes, where phase transition occurred within magmatic and hydrothermal systems, which can become an important tool in the interpretation of hydrothermal processes in the study area.

Keywords: copper isotopes; iron isotopes; hydrothermal systems; Yenice region; Biga Peninsula
Preliminary Results of Au-Sb Mineralization Related to Extensional Tectonics in the South of Biga Peninsula: Akçal (Balıkesir-İvrindi) Prospect Area

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Akçal Au-Sb mineralization is located in the south of the Biga Peninsula and about 25 km west of the Balıkesir province. Prospect area is geologically located in ‘Post-Orogenic Epigenetic Hydrothermal Mineralization Metallogenic Belt’ of Turkey Metallogeny map and in extensional tectonics related epithermal mineralization zone in the Metallogeny Map of Biga Peninsula.

In the Biga Peninsula, where exploration and mining activities operate intensively, tectonic and hydrothermal events as well as magmatism that develop at different times cause ore formation in different systems. Following the closure of the Neotethys Ocean, the extensional regime has taken place in different periods in the Cenozoic time. The N-S extension phase, which started in the Middle Miocene in Western Anatolia and still continues today, is defined by ~E-W striking normal faults with dip slip component in the Biga Peninsula. These faults, which cut the Miocene magmatic units, played an active role in the formation of E-W trending grabens in the region.

Lower Triassic aged Karakaya Complex consisting of metadetritic rocks with Permian aged limestone blocks is basement rock of Akçal (Balıkesir-İvrindi) licensed area. The Lower Miocene aged andesitic Şapçı Volcanics unconformably cover the Karakaya Complex and it is laterally and vertically transitional with the lacustrine Soma Formation containing the same aged lignite. In detailed geological studies carried out by MRE at Akçal area, highly silicified sinter, hydrothermal breccia, banded, colloform and cocard textured quartz vein-veinlets, locally chalcedonic silica and clayey (kaolinic) N75-85E striking tectonic zones have been identified. Drilling studies were conducted to determine the continuity, alteration and element content of the determined tectonic zones in the vertical direction.

The mineralization is observed in N75E/E-W striking parallel tectonic zones intersecting the Lower Triassic Karakaya Complex, the Lower Miocene Şapçı Volcanics and the lateral and vertical transitional lacustrine Soma Formation. 1/5000 scaled geology, mine geology mapping and detailed soil geochemistry studies were performed in the mineralization area. In order to determine the vertical dimension of the mineralization, drilling operations started in 2017. Texture and mineral assemblages determined in the surface are also observed in drilling cores. Disseminated, fine-crystalline pyrite, marcasite, orpiment in sinter, and antimony, pyrite, galena and sphalerite are observed in gray-dark gray quartz stockworks. Au grade is obtained from stockwork quartz vein-veinlet brecciated zones.

In the field, propylitic zone with chloritic, siliceous, calcite vein-veinlets; argillic zone with quartz vein-veinlets, disseminated pyrite; highly silicified silica caps, chalcedonic silisified hydrothermal breccia, banded and colloform textured quartz vein-veinlets are observed and mapped. Absence of alunite and dickite minerals argillic and advanced argillic alteration zones and presence of texture and structures mentioned above in the study area may indicate the formation of low-sulphidation Au mineralization in the study area.

Keywords: Akçal, tectonic; low sulfidation; epithermal
Mineralization Characteristics of Kaymaz Gold Deposit (SE Eskişehir, Central Anatolia)

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Kaymaz Gold Deposit (KGD) is one of the economically important deposits in the Central Anatolian Region. Geologically it is located in the eastern part of the Tavşanlı Zone and operated within 4 sites: Damdamca, Karakaya, Mermerlik, and Kızılağlı.

In the vicinity of KGD, the basement rocks are Triassic metamorphic units consisting mainly of marbles and schists and intruded by Eocene granitoids. They are tectonically overlain by Mesozoic serpentinites. Although granitoids intrude serpentinites in Tavşanlı Zone, a segment of the Eskişehir Fault Zone brought granitoid and serpentinites together at the northern part of KGD.

Gold mineralization is developed along the faulted granite-serpentinite contact in Karakaya and Damdamca sites (main zone). A significant amount of the economic ore is found in silicified serpentinite, while the little amount is observed within the granite near the contact. While the solution engendering mineralization caused intense silicification and rarely carbonation in serpentinites, silicification, and argillization developed in granites. Gold mineralization is in silicified serpentinite in Mermerlik Site. Unlike the main zone, there is no granite in the site. In Kızılağlı Site, the ore is located within the metamorphic rocks, and emplaced very close to the surface. The intense iron-oxide formation is accompanied by gold mineralization in all sites.

In addition to gold, significant silver enrichment is also common in Kaymaz Gold Deposit. Gold is not observed in most of the silver-containing samples. Similar to silver, there is no significant correlation between gold and other elements analyzed. Opaque minerals together with the native gold are pyrite, arsenopyrite, galenite, native silver, acentite, iodargyrite and goethite ± lepidocrocite. Also, some relic chromite and Ni-sulfides exist in serpentinites.

The results obtained from the fluid inclusion analysis of quartz vary from site to site. Homogenization temperatures (HT) were measured in Damdamca and Karakaya vary between 100-250 °C and 330-370 °C indicating two different phases. Salinity equivalent (SE) values are between 1.2-3.7 %. HT of Kızılağlı Site are between 270-393 °C and SE values are between 3.9-5.4%. It is inferred that the SE and HT values obtained from Kızılağlı Site belong to a different phase which causes silver enrichment in the metamorphics.

By the evaluation of all data (eg. low salinity equivalent values, mineral paragenesis and the shape of ore body) it is asserted that mineralization is the product of a low-sulfidation type epithermal system where multiple phases are effective. Moreover, tectonic activities that induced the granite and serpentinite tectonic contact were probably effective on mineralization.

Keywords: Kaymaz; Central Anatolia; gold, fluid inclusions; low sulfidation epithermal system
Volcanogenic massive sulfide (VMS) type mineralizations are frequently seen in the Eastern Black Sea region. The Sinkot prospect area is one of them and it is located close to the currently operated Çayeli, Murgul and Cerattepe deposits. Mineralization in the Sinkot area is formed as massive in sea floor, and stockwork-disseminated in submarine (sub-seafloor replacement). While pyrite-dominated massive parts consist of Au and Zn and relatively rich in Pb, it is observed that the stockwork-disseminated parts are generally Cu-rich. Massive ore deposits (pyrite-chalcopyrite), which are concordant with the cover rocks, generally have regular shape. Stockworks which are not located beneath the massive body, but located in the depth are lens-shaped.

The mineral paragenesis of Cu rich veins and lenses in the massive part are pyrite, chalcopyrite, galenite, sphalerite, faîlerze, covelline, marcasite, pyrrhotite, molybdenite, bornite, enargite, bismuth, luzinithe, aikinite minerals and Cu-Bi-sulphur and Bi-Se-Cu-sulphide minerals are observed. Chalcopyrite, pyrite, sphalerite and galenite minerals are observed together in the pyrite rich parts’ fractures where chalcopyrite, galena and sphalerite minerals were formed. These newly discovered copper mineralizations reflect the environmental conditions in which typical VMS type copper mineralizations occur in terms of environment, formation and mineral paragenesis.

Deeper part of massive mineralization, stockwork and disseminated ore thickness varies from 25 m. to 75 m. The mineralization contains dominantly pyrite, chalcopyrite and rarely sphalerite. However, ore veins which can reach up to 0.50-0.70 m in thickness contains pyrite dominant chalcopyrite minerals. Based on the mineral distribution and lithological diversity, mineralization in Sinkot prospect area has been observed within the tuff, pyroclastic and dacitic lava of Kızılıkaya Formation and contact between Kızılıkaya Formation and Çağlayan Formation which is generally observed as cover unit. The copper grade is 0.80%, which give a favorable response to flotation process. After the cleaning step, a concentrate of 29.40% can be obtained with a total yield of 92.30 (sweep + coarse). The distribution of the silver in the sample is also investigated that only 20% to 30% of it is collected in copper products (concentrate, cleaning residues and sweep concentrate) and the remnant part remains in the pyrite.

**Keywords:** Eastern Black Sea; VMS, copper; mineralization; ore deposit.
Charaterization of the potential in some trace elements of the Edough Massif (North East of Algeria)

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East Algeria is characterized by deep tectonic events and numerous thermo-mineral springs with temperature up to 98 °C and which include signifcant abundance of Fe, Cu, Ni, Co, Cr and other trace elements. The study area is the Edough Massif which is located at the North-eastern part of Algeria. It is composed of gneisses with layers of leptynites. Above the gneiss comes a unit composed of garnet, kyanite, sillimanite and andalusite micaschists with metric layers of marbles. The metamorphic complex and the sedimentary cover were intruded during the Miocene by acid to intermediate magmatic rocks. The massif is crossed by large deep faults striking in N120 ° to 150 ° general direction.

The mineral deposits are numerous including skarn type Fe-Pb-Zn-Cu and W-As-Au hosted by Cretaceous flyschs and gneiss; and, veins with polymetallic mineralization hosted by Cretaceous flyschs. The hydrothermal alteration is pervasive in the Edough Massif. The lithological and tectonic configuration of the Edough Massif favoured the circulation of fluids, which strongly altered different lithologies.

The calculation of hydrothermal alteration (IFRAIS) rate as well as the quantification of their different types was carried out using the NORMAT method developed by Mathieu Piché in 2000. Unaltered rocks contain no hydrothermal minerals and have an IFRAIS value of 100%, while totally altered ones have an IFRAIS of zero. The different styles of hydrothermal alteration are represented by the normative mineral alteration indices IPARA, ISER, ICHLO and IPYRO which represent, respectively, the paragonitization, sericitization, chloritization, and pyrophillitization.

All of the Edough studied samples have low IFRAIS values (10-33 %), which confirms their hydrothermal alteration rate. Quantitatively, the alteration indices (IPARA, ISER, ICHLO and IPYRO) evolve with the intensity of the alteration (IFRAIS). The study of the rate of alteration reveals two groups: 1) IPARA (18%), ISER (57%), ICHLO (18%), IPYRO (6%) and 2) IPARA (30%), ISER (48%), ICHLO (11%), IPYRO (5%). Each group corresponds to distinct areas in the Edough Massif.

Geochemical anomalies and alteration indices have been described by the PCA method (Principal Component Analysis). The result shows: 1) a good relationship (R=0.8) between nickel-zinc and rock samples with ISER = 57% and ICHLO=18% and 2) an association (R=0.6) between highly paragonitized and sericitized rocks with IPARA = 30%, ISER = 48% and the trace elements lead and chromium.

The combination of factors such as large-scale faults, thermal-springs, metamorphism of different grades, mineralization group occurrences, diagnostic altered minerals such as chlorite, sericite and paragonite, as well as the close correlation between the different alteration indices (IPARA, ISER, ICHLO and IPYRO) and the geochemical anomalies in trace elements such as lead, chromium, zinc and nickel make the studied zone suitable for mineral exploration.

Keywords: Edough Massif; trace elements; alteration indexes; metamorphism
The Jebel Lassel (JL) Pb-Zn-F mineralization are widely found in the Djamila nappe which is the dominant structural unit in the Kherrata area (northern Algeria). The mineralization are hosted in Upper Cretaceous limestone and marly limestone. They were formed in tension veins of different fillings and directions which can be divided into several types: (i) galena-calcite veins, (ii) sphalerite-calcite veins, and (iii) fluorite-calcite veins hosted by marly limestones of Senonian age. The ore mineralogy consists mainly of galena or sphalerite, fluorite, and pyrite. Supergene oxidation minerals include cerussite, smithsonite, and iron oxides. Calcite, and to a lesser extent quartz are the main gangue minerals.

The $\delta^{18}O$ and $\delta^{13}C$ results were obtained on late fracture filling calcite (CaIII) from Jebel Lassel in association with galena, sphalerite, and fluorite. The $\delta^{13}C$ PDB values of the calcite gangue, which vary between -1 and +2‰, indicate an inorganic carbon origin and are consistent with a marine origin of the host rocks and heritage. Values of $\delta^{18}O$ SMOW of calcite crystals are between +16 and +25‰ and the oxygen isotope composition of waters in equilibrium with calcite was calculated using the coefficient of fractionation curve of oxygen isotopes between calcite and water given in Zheng (1999) and estimated between +4‰ and +14‰. These values are consistent with the values of typical deep brines in sedimentary basins. $\delta^{34}S$ values, which vary from 9.5 to 9.8 (galena) and from 12.7 to 14.5‰ (sphalerite), and the temperature of the fluid (100–180 °C) exclude all possibilities of bacterial sulfate reduction indicating that the source of the sulfur is the thermochemical reduction of sulfate from Triassic evaporates ($\delta^{34}S = +15‰$).

Combined, geological, mineralogical, isotopic, and geochemical data of vein mineralization at Jebel Lassel and Bou Izem confirm the epigenetic character of the mineralization and enable us to classify them as Mississippi Valley type deposits.

**Keywords:** Kherrata; Algeria; Triassic; Djamila nappe; fluid inclusion; Jebel Lassel; Bou-Izem; stable isotopes;
Mineralogy and geochemistry of the Fe-Mn crusts and nodules in piemontite-schists of the Cycladic Blueschist Unit rocks of Varnavas area, NE Attica, Greece

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The lower NE Attica Unit consists of a greenschist facies metamorphosed volcaniclastic sequence at its base and an overlying carbonate sequence. Piemontite-schists horizons within this unit are associated with calcareous schists, and quartz-mica schists and enclose Fe-Mn crusts and Mn-nodules. Detailed investigation combining geochemical (major, trace elements and REY) and mineralogical (SEM, XRD, Raman) analyses of these Mn and Fe-oxides allow the identification of the poorly crystallized minerals. The cryptocrystalline nature of the nodules requires a multiple-method approach for sufficient data acquisition. The studied ore occur in Mn-oxide rich nodules and quartz-hematite intercalations. We have established that these nodular forms have pyrolusite as the dominant manganese oxide. The hematite intercalations are well established with strong X-ray diffraction peaks. These minerals are good scavengers of metallic elements and REE. Bulk geochemical analysis of the Mn-rich ore shows high Mn/Fe ratios (2.9 – 5) and discrimination ternary diagrams (Fe – Mn – (Co + Ni + Cu) and Si – Fe – Mn) suggest a hydrothermal origin. Mineral chemical data and bulk geochemical data are compared with literature data from Mn-deposits of known tectonic environments in order to draw some implication for the paleogeographic depositional environment of the Mn-rich sedimentary protolith.

Keywords: Mn-nodules; Fe-Mn crusts; piemontite; Raman spectroscopy
Mineralogy, geochemistry and C, O isotope study of the iron-oxide deposit at Grammatiko, NE Attica, Greece: ore genesis in an extensional setting

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The Grammatiko Iron oxide deposit (NE Attica region, Greece) is one of the economically most significant iron deposits in the Attic-Cycladic metallogenic province which was extensively mined until 1912. Mineralization is hosted in marbles and developed in the form of replacement bodies. These bodies are structurally controlled and follow large subvertical fracture zones with a NNE-trending strike that are associated with the Late Miocene extensional tectonic regime in the region. The mineral paragenesis consists mainly of Fe-Mn-Ba minerals including hematite, Mn-goethite, pyrolusite, hollandite, barite as well as traces of sulfides (e.g. galena). Gangue minerals are mostly calcite, ankerite and minor quartz and muscovite. Supergene minerals include limonite and Fe-Mn and Zn-oxy-hydroxides. Bulk ore analyses show concentrations of Mn up to 3 wt% and high contents of Pb and Cu. Microscopic observations, textural relationships and detailed SEM/EDS analyses showed minor contents of sulfur (<1 wt %) in some coarse grains with tetrahedral morphologies possibly indicating hematite formation after primary pyrite. Carbon and oxygen isotope analyses of carbonates collected along a traverse extending from the ore-bearing zone to the unaltered/non-mineralized marble show $\delta^{13}C$ values between $-10.5$ and $-4.5\%$ and $\delta^{18}O$ values from 20.9 to 24$. For the non-mineralized marble host rock, $\delta^{13}C$ values range from 2.2 to 2.8% with $\delta^{18}O$ values between 26 and 30.3%, respectively. The isotopic composition records the variable degree of hydrothermal alteration of the marble host rock as well as the characteristics of the ore-forming fluid. Unmineralized marbles exhibit a marine signature whereas vein calcite in the mineralized parts reflects a contribution of isotopically light carbon, likely from oxidized organic matter. In summary, $\delta^{13}C$ and $\delta^{18}O$ values from the Grammatiko mineralized carbonates record a complex interaction between marine carbonate and surface (meteoric) fluid.

Keywords: Grammatiko deposit; hematite; Mn-goethite; Carbon and Oxygen isotopes
Geology, geochemistry and isotope characteristics of Darıderesi (Balıkesir, Turkey) Pb-Zn (Au-Ag) mineralization

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Darıderesi Pb-Zn mineralization is located in SE Biga Peninsula, which is situated in 45 km NW of Balıkesir, Turkey. Pb-Zn occurrences are structurally controlled mineralization which are associated with the horse-tailing segments and joints of Balya Fault (N40°E/50°NW) (dip-slip normal fault) that are cutting allochtonous, Permian aged Çamoba limestones and Triassic aged Karakaya Complex which occurs as the basement, that consist of mudstone, siltstone and sandstones. The basement rocks are overlaid by Oligocene-Miocene aged dacitic lava, tuff and pyroclastic rocks of Hallaçlar Volcanics and Upper Miocene aged andesitic dyke, lava and agglomerates of Şapçı Volcanics.

Darıderesi mineralization occurs as a skarn; in the exoskarn epidotes, quartz (quartz-I) and calcite minerals were observed, however, no endoskarn zone was observed in the region. Galena, sphalerite, pyrite, chalcopyrite and arsenopyrite were detected as ore minerals. Mineralization forms as a sequence of pyrite, sphalerite I, galena, chalcopyrite, and sphalerite II formation. Due to mineralization characteristic type, positive correlations of Pb, Zn, Ag, Cu, Au, Sb, Hg and As with each other and also the correlation of Pb-Ag-Te, Zn-S, Cd-Au, B-Bi-Sn, Ag-Pb-Te-W, Cu-K-Rb-In-Bi, As-Fe are results of ore mineral parageneses of arsenopyrite, pyrite and chalcopyrite, which shows temporal and spatial relationships in many sections.

Homogenization temperatures of calcite, sphalerite and quartz shows crystallization temperature of gangue minerals is changing between 300-340°C (1.6 - 13.0 % NaCl equiv.), 280-320°C, and 220-330°C (1.4 - 10 % NaCl equiv.). The δ⁳⁴S values obtained from the mineralization are in the range of ‰ -0.4 to 0.9 for galena, ‰ 1.4 to 2.7 for sphalerite and ‰ 1.9 to 3.1 for pyrite. Accordingly, the origin of sulfur was interpreted to be magmatic. Lead isotope ratios of galena ore are ranging between 18,806-18,839 for ²⁰⁶Pb/²⁰⁴Pb; 38,982-39,021 for ²⁰⁷Pb/²⁰⁴Pb; 15,702-15,715 for ²⁰⁷Pb/²⁰⁴Pb. These data indicate that the lead could be derived from the sources in lower crust-mantle and also it was emplaced by igneous activities with a minimal contribution from upper crust. The epigenetic deposition of Pb-Zn-Cu mineralization in the form of veins, the high content of trace elements and the δ⁷⁸S isotope ratios indicate hydrothermal origin.

The mineralization type for Darıderesi Pb-Zn is proposed to be intermediate sulfidation epithermal, rather that skarn, based on the ore-alteration-wall rock relations, mineral assemblages of the alteration zones, the temporal and spatial distribution of the alteration zones and fluid inclusion studies.

Keywords: Biga Peninsula; Darıderesi Pb-Zn mineralization; skarn; epithermal; fluid inclusion; isotope geology
B.1. Metallic Deposits in the Mediterranean Region
International Earth Science Colloquium on the Aegean Region, IESCA-2019, Izmir, Turkey

B1-13

Comparative investigation of Esendemirtepe skarn and Horoz skarn mineralizations in Ulukışla (Niğde) Basin

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The Ulukışla Basin has formed in the post-collisional tectonic environment on the suprasubducted Alihoca Ophiolitic Complex caused by the collision of the Niğde Massif from the north and the Tauride Carbonate Platform from the South, until Upper Cretaceous, and is a result of the post-collisional tectonic environment. As a part of this post collisional extensional regime; the Ulukışla Formation consists of magmatic, volcanic, volcano-sedimentary and limestone units. The Esendemirtepe Diorite (60-56 Ma)(7) located in the Ulukışla Formation, has been exposed to ore forming processes leading to the occurrence of skarn type mineralization in the limestone levels within the volcano-sedimentary unit. After the occurrence of the Ulukışla Formation from the extensional tectonic setting, the Horoz Granitoid (56-47 Ma)(8,9,10) has been intruded into the Tauride Carbonate Platform during the later collisional tectonic regime.

The two skarn mineralizations investigated in this study both include endoskarn and exoskarn zones. While Horoz has extensive endoskarn zones, Esendemirtepe has rarely. Biotite and pyroxene in Endoskarn zone in Esendemirtepe are prograde stage minerals, whereas the garnet in Horoz endoskarn characterizes the prograde stage. Amount of garnet is greater than that of the pyroxene during prograde stage of the Esendemirtepe exoskarn, whereas in Horoz exoskarn only garnet exists. The tremolite-actinolite, and epidote crystallization in Esendemirtepe during the retrograde stage are very dense. However in Horoz, epidote is dense but tremolite-actinolite is seen rarely. During hydrothermal stage, in Esendemirtepe, two-phase quartz and single-phase calcite forms. On the contrary, in Horoz single-phase quartz and calcite is found. During prograde and retrograde stages, magnetite has formed densely in Esendemirtepe, whereas in Horoz, magnetite cannot be found during the prograde stage. In Esendemirtepe, chalcopyrite exists densely both in magnetite fissures and in quartz, whereas in Horoz, it is rarely found as relic. During hydrothermal stage, tetrahedrite, digenite and during supergene stage chalcocite is observed in Esendemirtepe, while none of these exist in Horoz. Roof pendant can only be seen at the heights of the Horoz skarn, whereas Fe oxides and hydroxides are very rare in Esendemirtepe mineralization. The supergene stage mineralogy of the roof pendant in Horoz contains dense hematite, limonite, and goethite-lepidocrocite and secondary Zn minerals. As content in the geochemically data suggests that at least some of these iron oxide/hydroxides include As (possibly As-bearing iron oxides, scorodite and/or arseniosiderite) and are remnants of arsenic bearing sulfide species. In Esendemirtepe, 10 to 15 μm sized electrum is included in magnetite. Native gold, 15 to 20 μm size is also found in quartz of the first hydrothermal stage. On the contrary in Horoz, 5 to 10 μm sized electrum is found in the quartz of the hydrothermal stage. When we attempt to sort these two skarn mineralizations with respect to their ore anomalies according to these data, we see that the Esendemirtepe skarn shows the characteristics resembling the Fe – Cu – Au skarns, whilst the Horoz skarn shows the properties resembling the Fe – Zn – Au – Cu skarns.

Geochemically, Esendemirtepe Diorite both Esendemirtepe Diorite and Horoz Granitoid are relatively high Sr/Y and La/Yb ratios, which increase with SiO2 (where trends are visible); minimal europium anomalies (Eun/Eu* ≈ 1); and light REE enrichments, but flat to concave-upward (listric-shaped) MREE-HREE patterns, reflected in [La/Sm]n ≈ 4–8 and [Dy/Yb]n ≈ 1.0–1.5 (12) and increasing V/Sc ratio (13) presents characteristics of the hydrated-oxidized magmas that are usually correlated with the occurrence of the porphyry-type mineralizations.

Keywords: Ulukışla Basin; Horoz Granitoid; skarn mineralization
The Relationship between physico-chemical properties of solutions and structural control on Efemçukuru hydrothermal mineralisation

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Efemçukuru (İzmir-Turkiye) Au-Ag epithermal vein system is located at the Seferihisar horst which is bounded with major faults named as Orhanlı at the East and Seferihisar at the West part of the uplift. The horst consists of the marine clastic sequence, which is named as Bornova mélange. Alkali rhyolitic dykes, which are members of Cumaovası volcanics are mostly West-Northwest oriented and dipping 35-55 degrees to North- Northeast. The other group of dykes is oriented to Northwest and dipping 60 degrees to Northeast. Multiphase vein system occurrences are between West to Northwest oriented rhyolitic dykes. The mineralisation is hosted by the NW-SE trending fault systems dipping NE between 45° to 65°.

This study aims to reveal the relations between the physico-chemical properties of hydrothermal solutions and structurally controlled ore formation. Structures, multi-stage vein phases and associated textures were classified and mapped. The geological and structural works exhibited the high gold grade veins formed into the extensional link faults on relay ramp settings that is constructed by two oblique slip normal faults. The fluid inclusion studies were done at each of the ore shoots at Kestanebeleni deposit.

At south ore shoot (SOS), the salinity of early stage quartz-rhodonite dominated phases has a relatively wide range between 0.2% and 7%. The average salinity is 1.9 eq. wt. % NaCl. Salinity of quartz-rhodonite-sulphide phases which cross cut the earlier quartz-rhodonite phase is in the range of 1.1%-6.7% NaCl with an average of 3.7 eq. wt. % NaCl. Homogenization temperatures in quartz-rhodonite-sulphide phase vary between 236.2 °C to 374.2 °C with an average temperature of 286 °C. Homogenization temperatures of fluid inclusion assemblages (FIA) of early quartz rhodonite phase vary in a range between 182.5 °C -312.2 °C. The average of homogenization temperature is 252 °C.

At middle ore shoot (MOS), the salinity of quartz-rhodonite-sulphide phases are scattered in a narrow range between 1.5 and 2.5 eq. wt. % NaCl. These FIA’s of quartz-rhodonite-sulphide phases yielded homogenization temperatures between 250 °C and 300 °C. The average salinity of the late stage base metal phases are increases up to 7.6 eq. wt. % NaCl, with the average homogenization temperatures of 245°C.

At north ore shoot (NOS), the average salinity of quartz-rhodonite-sulphide phase is 5.1 eq. wt. % NaCl with an average homogenization temperature of 270 °C.

The preliminary results show that FIA’s in Quartz-rhodonite-sulphide vein homogenizes to liquid phase at about 250 °C with the salinity range between 2.5% - 3.5%; which represents the optimum conditions for high grade gold precipitation in overall Kestanebeleni vein system. The ratio of salinity usually increases in to northward but lower ratios are observed at MOS due to addition of meteoric fluids at relay ramps where the strong deformations are occurred. As a result, this imbalances the gold precipitation conditions, causing of variability in gold grade distribution.

Keywords: Efemçukuru; epithermal; gold; fluid inclusion; relay ramp
Scientific Session B.2

Industrial Raw Materials & Gemology in the Mediterranean Region

Conveners:
Dr. Muazzez ÇELİK KARAKAYA;
Dr. Mümtaz ÇOLAK; Dr. İbrahim GÜNDOĞAN
The evidences of some stable isotope compositions of the Miocene halites related on the origin of the salts (Tuz Gölü, Turkey)

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The study area located in the south of Konya Closed Basin, Central Anatolia contains ancient (Miocene) and recent evaporite deposits. The aim of the study is to determine the origin of the Miocene halites of the Tuz Gölü basin based on isotope data. For this aim, the isotopic properties of halite samples taken from three different drillings in the study area were investigated. The $\delta^{81}\text{Br}$, $\delta^{37}\text{Cl}$, $\delta^{7}\text{Li}$, and $\delta^{11}\text{B}$ isotopic compositions of the pure halites range from $-0.06$ to $0.82$, $-0.80$ to $1.28$, $-0.70$ to $30.60$ and $-14.70$ to $11.60$, respectively. The low $\delta^{37}\text{Cl}$, $\delta^{81}\text{Br}$ and high $\delta^{11}\text{B}$, $\delta^{7}\text{Li}$ values clearly indicate that the brine involved in the formation of the halites of the Tuz Gölü basin was largely derived from seawater. Additionally, intermediate and high $\delta^{37}\text{Cl}$, $\delta^{81}\text{Br}$ and low $\delta^{11}\text{B}$, $\delta^{7}\text{Li}$ values of the investigated samples refer that the origin of the ancient halites in the basin is not only a marine composition but also a mixture of solutions having different compositions or origins (e.g., seawater or saline water and groundwater/fresh water).

Keywords: Tuz Gölü basin; evaporate; isotope; halite
Origin Assessment of the Miocene and Recent evaporite deposits in Tuz Gölü Basin

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The study area is located in the southeastern part of the Salt Lake basin. There are many recent perennial saline and alkaline lakes namely Tuzgölü, Bolluk, Tersakan and Acıgöl. The lakes are located on Paleozoic to Neogene basement rocks composed of metamorphic rocks, ophiolites, limestones, volcanics, evaporitic deposits (mainly gypsum, halites, Na-Ca-sulphates) and detrital sediments. In the Miocene sediments, gypsum and anhydrite minerals are predominantly widespread and glauberite and halite are determined together in many levels whereas in recent surface deposits, thenardite and halite are common. The Cl and Br ion content of the recent surface and Miocene halite show that the recent halites and the Miocene halites were originated from similar source. Additionally, high Cl and low Br content of the halites indicate mixing process of the Tuz Gölü basin. \( \delta^{37}\text{Cl} - \delta^{81}\text{Br} \) isotope contents of the recent surface and the Miocene halites show also similar origin and the low \( \delta^{37}\text{Cl} \), low \( \delta^{81}\text{Br} \) values indicate marine origin. Mixing process also supported by the intermediate \( \delta^{81}\text{Br} \) and high \( \delta^{37}\text{Cl} \) isotope contents.

The geochemical and isotopic results indicated that the formation of recent surface and the Miocene halites in the Tuz Gölü basin was affected by more than one mechanism including: i) a mixing of solutions having different compositions/origins, ii) marine origin.

**Keywords:** halite, evaporite, Konya Basin.
Hydromagnesite formation and its significance in the Çameli Basin, Southwestern Turkey

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Hydromagnesites which were derived from the magnesium-rich basement rocks of the Lycian Nappes are observed in Çameli Basin (SW Turkey) that is generally made up of upper Miocene-lower Pleistocene deposits of the Çameli Formation, which was divided into the Derindere Member (terrestrial clastics) and Değne Member (lake deposits). Değne member is predominantly composed of yellowish marls, white-beige sandstones, claystones which are mainly exposed in the southern side of the basin. The uppermost part of Değne Member includes grayish, beige limestones and extremely white Mg-carbonate layers. Even the huntite take places as a common mineral throughout the Çameli Basin, the Mg-carbonate layers are mainly composed of hydromagnesite and minor contributions of huntite, dolomite and magnesite. The changes in the Mg/Ca ratio of the lake water resulted in an alternation of limestones and Mg-carbonates. Data from the recent lakes such as Alchichica (Mexico), Atlin and Milk (British Columbia), Siling and Dujiali (Tibet), Walyungup (Australia), Salda (Turkey) indicate that the hydromagnesite precipitates along the lake shore according to presence of microbialite which rapidly increases the ratio of magnesium in the lake water. The uppermost part of the Çameli Formation implies a magnesium rich lake environment like the recent examples.

Keywords: Çameli Basin; hydromagnesite; huntite; magnesium carbonate; Salda Lake
In this study, the mineralogical and petrographic properties of Bayburt amber, identified for the first time in 2015 at the Dokuz Eylül University Geological Engineering Department, are presented. These amber formations are found in Sirataşlar Formation that consists of Eocene limestone, sandstone, gravel, occasional marl and sandy limestone. The nodular shaped ambers are generally present in the mudstone, sandstone and small quantities of marl and their size ranges from millimeters to centimeters (up to 40 cm, usually around 3-10 cm). Channel formations filled with sand and gravel are observed near the upper segment of the amber-bearing layers. Preliminary field observations points out that the amber-bearing clastics were deposited in a submarine delta environment. The Sirataşlar formation is unconformably overlain by the Hozbirlik Plateau limestone and Otlukbeyi mélange. Yazyurdu formation which consists of andesite-basalt lava, andesite-basalt agglomerate and tuff alternations, lie unconformably on the Sirataşlar formation.

The hand specimens of ambers are usually honey yellow, orange and dark red in color. They are physically deformed in the banded sedimentary rocks due to intense tectonic activity. Observable amounts of rarely seen calcite and pyrite occurs inside micro cracks which are resulted from tectonic deformation. The amber formations usually display a very homogeneous polymerization under electron microscope and they usually exhibit trace amounts of barite, calcite, opal and orthoclase formations. The barite minerals which go up to 8 microns in length are crystallized as radial rosettes. The calcite, opal and orthoclase minerals are secondary occurrences that fill-in the tiny cracks in the amber. At some levels, amber formations are accompanied by up to 15 cm black colored jet-like organic and branch-like ligneous formations. Pyrite fills the cracks and gaps in these jet-like occurrences locally.

The FTIR identification of amber is based upon the presence of characteristic absorption bands located at 2932 and 2847 cm⁻¹. The comparison of infrared spectra of Bayburt amber, and the Baltic and Dominician ambers indicate that there are differences between 500-1500 cm⁻¹, and shows totally different characteristics in the 1050–1350 cm⁻¹ range.

Keywords: Bayburt; amber; gemology; SEM; FTIR
Clay mineralogy and geochemistry of Turgut coal bearing sediments (Muğla-Turkey)

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The coal-bearing Yatağan Basin is located to the eastern coast of the Aegean Sea, in southwestern Anatolia, Turkey. The basement consists of Menderes Massif metamorphic rocks. The Miocene sequence which unconformably overlays the basement is subdivided into two formations: Eskihisar and Yatağan. Eskihisar Formation, comprises Turgut and the major coal-bearing Sekköy members. Turgut member includes conglomerate, sandstone, mudstone, limestone, siltstone with coal layer-mudstone deposited under alluvial fan, fluvial and lacustrine deposits from bottom to top, whereas the Sekköy member includes mudstone, coal, silty claystone, mudstone, marl and limestone deposited under lacustrine conditions. The Eskihisar formation is conformably overlain by the Yatağan formation that includes conglomerate, sandstone, limestone-marl-mudstone deposited under alluvial fan and lacustrine conditions. Quaternary alluvial fan and fluvial deposits cover Yatağan formation. Sekköy formation containing economic coal bearing horizon about 15 m thick. Thickness of coal seams are between 2 and 12 meters. Marl, marly calcareous, clay, silt and sand units overlie the coal-bearing horizon. Marly rocks were seen rarely, most of them are silty, sandy mudstones. These rocks were not completed their diagenesis process. The thickness of the marly levels are high at the south of basin near to calcareous host rocks. In this context, diagenesis process of mudstone rich levels, especially clay bearing rocks aims of this study. For this purpose, samples were taken from boreholes to determine mineralogical and geochemical characters of the clay rich samples.

Mineralogical analysis shows that bulk samples consist of quartz, feldspar, mica and clay minerals, additionally, only three samples contain calcite and aragonite minerals. Mineralogical composition of <2µm size fraction of the samples consist of smectite, kaolinite and illite in different percentages according to the locations of the samples. Major oxide concentrations of samples are about on average SiO2 53.71 wt.%, Al2O3 20.90 wt. %, Fe2O3 4.61 wt.%, MgO 1.34 wt.%, CaO 2.29 wt.%, Na2O 1.26 wt.%, K2O 3.40 wt.%, TiO2 0.73 wt.%, P2O5 0.09 wt.%, MnO 0.03 wt.%, Cr2O3 0.01 wt.%. Correlations are determined between mineralogical and geochemical results according to the different diacritical lithologies whereas limestone sedimentation is not common. The negative anomalies for Eu based on North American Shale-Composite (NASC) indicate that the sediment samples were derived from a plagioclase-rich source rocks.

Keywords: smectite; kaolinite; metamorphic; gneisses; lignite; mineral transformations
Scientific Session B.3

Water & Geothermal Resources in the Eastern Mediterranean Region

Conveners:
Dr. Melis SOMAY; Dr. Alper BABA; Dr. Gültekin TARCAN
Use of primary geodetic data in identifying the active deformation in geothermal areas: the Aristino (NE Greece) case study

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The objective of the present paper is the determination of the active tectonic deformation patterns in the Aristino area (Thrace, NE Greece), using primary geodetic data derived by permanently installed GPS/GNSS stations, as well as the examination of how this pattern is related to the geothermal anomaly in this area.

The geothermal field of Aristino covers a very small part (20 km²) of the huge (700 km²) Evros Delta Basin. The basin has been filled by as much as 3,500 m of sediments that have been uncomfortably deposited on the basement formations (flysch, gneiss, amphibolites, etc). The broader area is characterized by extension, leading to the occurrence of a major NNE-SSW fault zone that is related to the local geothermal activity.

The geodetic data are collected by 11 permanent GPS/GNSS stations, whereas the recording was carried out for a seven-year time period. The data processing was based on the triangulation methodology, in order to extract the necessary parameters and determine the neotectonic regime and the geotectonic evolution of area.

Keywords: Neotectonic activity; GPS/GNSS stations; geothermal energy
Geothermal Mineral Recovery Possibilities in the High Temperature Geothermal Systems in Western Anatolia

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High temperature geothermal sources have been used for geothermal power production and it is possible to provide more energy by a geothermal combined power and heat system from these sources. Moreover, it is still possible to make a new economic gain with solving an operational problem after the energy production from geothermal brine in the system.

Deep geothermal fluids contain different minerals due to water-rock interaction in high temperature system. Some of minerals tend to be precipitate with changing thermodynamic conditions from depth to surface like calcite, metal silicates, sulphide minerals. After steam separation, saturations of a few minerals in brine may increase at the flash and advanced geothermal power systems in high temperature systems. These minerals such as silica, lithium, boron or trace elements can be used with industrial purposes after the mineral recovery and leaching processes.

In this study, mineral recovery possibilities are investigated in high temperature geothermal systems in Western Anatolia (Turkey).

Keywords: geothermal; brine; mineral recovery; high temperature systems; power production; geothermal mining
The evaluation of nitrate concentrations in Alaşehir Sub-basin groundwater sources for sustainability

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Every passing day, the human pressure on the natural resources required for the earth to continue presenting a sustainable life is increasing. Human activity without overseeing the operations of the ecosystem is the center of most issues such as pollution, global climate change, desertification, erosion and more. In the Common Future Report published by IPCC in 1987, it was noted that the development model that is defined by fulfilling the needs of today, while giving no compromises for the right of future generations to fulfill theirs can only be possible with providing environmental sustainability. At this point one of the most important extents to environmental sustainability is the main source of life, which is water. However, nitrogen which is a very important input in agricultural production, causes environmental pressure on water, dirt and air. Possibly, the most damaging effects of the widespread use of fertilizers with nitrogen is the ground-water quality’s corruption, the pollution of drinking water which can create a risk for human life. Because of that, defining the factors that affect the nitrate concentration in ground-water and defining the characterization of ground-water pollution in order to control and oversee the ground-water quality has come into prominence.

In this study’s extent, the ground-water and surface water sources in Alaşehir Sub-basin were examined regarding their nitrate levels. The factors that affect the nitrate concentration were defined and the sustainability of the ground-water in the basin was examined accordingly to the indicators created by Eurostat.

The nitrate concentrations acquired in the extent of the study are as follows: In the Bozdağ ground-water sources it's at the highest 148,7 mg/L in 52 examples, median being 2 mg/L, in Gediz River it's 25,3 mg/L at the highest in 23 examples, median being 2 mg/L, in the alluvial aquifer that's being fed by the river in 79 examples it's 117,3 mg/L and the median is 4,4 mg/L. The 10 examples used to compare were taken from Küçük Menderes Basin ground-water and the highest concentration was 76,1 mg/L and the median was examined as 5,8 mg/L. In a research made in the European Union countries the median value was noted as 1,6 mg/L. It is seen here that there is a big importance in plant usage and denitrification on the reduction of nitrate concentrations.

Keywords: ground water; pollution; sustainability; nitrate
Reinjection and dissolution of carbon dioxide in the geothermal fluids:
An example from Aydın-Salavatlı (Western Anatolia) geothermal field

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Carbon dioxide in the geothermal area plays an important role in terms of environmental hazard. In most of the geothermal fields, dissolved gases in the geothermal fluids are released to the atmosphere. Among the energy producing western Anatolian geothermal fields, composition of the non-condensable gases (NCG) are generally around 97-99%, which is even above the thermal plants’ values. Therefore, it is crucial to take the carbon dioxide behavior into account in both reinjection and dissolution steps in the geothermal systems. These regarded steps will provide to avoid high carbon taxes and benefit a share from the carbon reduction revenues.

In this study, reinjection and dissolution of carbon dioxide released from the geothermal plants was investigated in Aydn-Salavatlı (Western Anatolia) geothermal system. In order to model the reinjection and dissolution of carbon dioxide in this geothermal area, following steps were performed: i) geochemical analysis in both geothermal water-steam, gases, and rock/minerals, ii) scaling features, iii) modelling with Aquachem-PhreeqC and Petrasim-Tough2.

According to the analytical and modelling results based on the Aquachem-PhreeqC program, when the calculated temperature of the reinjected carbon dioxide fluid is around 80 °C, precipitation of the carbonate and the scaling in the geothermal fluid, which reaches to the reservoir is unlikely observed. In addition to that, data from the production (AS3, AS4, DORA II) and reinjection bores (ASR4, ASR5) of the Aydin-Salavatlı geothermal system is modelled by using the Petrasim-Tough2 to project three different conditions: i) for 0.7% CO₂, Pf: 13.1 bar, pH: 5.7; ii) for 1.3% CO₂, Pf: 23.9 bar, pH: 5.4; iii) for 2.7% CO₂, Pf: 50.5 bar, pH: 5.1. Based on these 3 different conditions, the features of the dissolved CO₂ in the reinjection fluid and the changes during the production period are examined and concluded. The injection of carbon dioxide into the reinjection of the geothermal reservoirs is crucial and important for the environmental act. This step will provide decreasing in paying carbon-release related taxes and increasing the production rates of the geothermal systems.

Keywords: Western Anatolia geothermal systems; Carbon dioxide; carbon capture, modeling.
Water reservoir lifetimes from catchment-wide 10Be erosion rates – A case study from the central Menderes Massif (Western Turkey)

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The functionality and retention capacity of water reservoirs is generally impaired by upstream erosion and reservoir sedimentation, making a reliable assessment of erosion indispensable to estimate water reservoir lifetimes. Widely used river gauging methods may underestimate sediment yield, because they do not record rare, high-magnitude events and may underestimate bed load transport. Hence, reservoir lifetimes calculated from short-term erosion rates should be regarded as maximum values. We propose that erosion rates from cosmogenic 10Be, which commonly integrate over hundreds to thousands of years, are useful to complement short-term sediment yield estimates and should be employed to estimate minimum reservoir lifetimes. This study presents 10Be erosion rates for the drainage basins of six water reservoirs in the central Menderes Massif, which are located in a tectonically active region with easily erodible bedrock. The 10Be erosion rates for these catchments are high, ranging from ~170 to ~1,040 t/km²/yr. When linked to reservoir volumes, they yield minimum reservoir lifetimes between 25 ± 5 and 1,650 ± 360 years until complete filling, with four reservoirs having minimum lifespans of only ~110 years. In a neighboring region with more resistant bedrock and less tectonic activity, much lower catchment-wide 10Be erosion rates of ~33 to ~95 t/km²/yr were obtained, illustrating that differences in lithology and tectonic boundary conditions can cause substantial variations in erosion even at a spatial scale of only ~50 km. In conclusion, it is suggested that both short-term sediment yield estimates and 10Be erosion rates should be employed to predict the lifetimes of reservoirs.

Keywords: water reservoirs; water reservoir lifetimes; catchment-wide 10Be erosion rates; Menderes Massif, Turkey
Classification and codification of karst aquifers in Aegean islands

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Karstwater is important natural resources for the water supply for domestic and irrigation use. The karst aquifer systems of Greece are developed in carbonate sedimentary (limestone, dolomite) and metamorphic rocks (marbles) and contribute significantly to water supply for domestic and irrigation use. Karst aquifers discharge through springs: submarine, coastal brackish and inland freshwater springs. The hydraulic parameters of the karstic aquifer systems range within a large scale of values depending on karstification, tectonics and stratigraphy.

This work presents the classification of 42 distinct karst aquifer systems in Aegean islands. These aquifers were classified according to five criteria: 1) Lithology, 2) Position, 3) Quality status, 4) Exploitation and quantitative status, and 5) Springs discharge.

The classification of karst systems codified in the Implementation of the Water Framework Directive of the Special Secretariat for Water (Ministry of Environment and Energy) shows that 25 out of a total of 42 karst systems are developed in marbles and is of good quality and quantitative status. Poor quality status and quantitative status is recorded in 12 aquifers due to seawater intrusion phenomena. The brackish waters are of the sodium-chloride (Na-Cl) type.

This review summarizes the characteristics of the karst aquifers in Aegean islands for ensuring the sustainable management of groundwater resources. It is obvious that the aforementioned classification and codification could be completed with more detailed data in the future.

Keywords: Greece; islands; karstwater
Scientific Session B.4

Construction Materials

Conveners:
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Dr. Ali Bahadır YAVUZ
B.4. Construction Materials

International Earth Science Colloquium on the Aegean Region, IESCA-2019, Izmir, Turkey
Assessment of the durability of different travertine lithotypes used as armourstone around the coasts of Lake Van

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Lake Van is the world's largest salty and soda lake with a surface area of 3713 km², a perimeter of 430 km and a lake water pH of 9.8. The height of Lake Van from the sea is now 1646m. However, it is known that lake water level increases to different levels due to climate and tectonic events in different periods. For this reason, coastal protection structures were built around the lake in order to protect against both wave effects and water rises. In this study, it is aimed to determine the stability and performance of travertines with different lithotypes used as armourstone material on the Edremit coast which contains the largest marina of Lake Van with accelerated weathering tests. Travertines reveal different lithotypes depending on their depositional characteristics such as crystalline crust, shrub, reed which can affect engineering properties of travertine and each level has different durability performance. At the southeast of Lake Van, it is determined that the travertine at that spot has shrub (EDR-1), reed (EDR-2) and crust (EDR-3) levels. Moreover, core samples were retrieved from different lithotype travertines used in the armourstone in the existing marina and density, water absorption, porosity, uniaxial compressive strength, sonic velocity, Micro Deval abrasion values of three different lithotype samples were determined. In addition, percentage loss amounts of the samples after deterioration were determined by performing wetting-drying, freezing-thawing and salt crystallization cycles on these samples. All experimental results were evaluated with quality evaluation criteria proposed by CIRIA and durability performances of travertines with different lithotypes were determined. Accordingly, lithotype has a considerable effect on the physical, mechanical and durability performance of travertine levels. In particular, the physical and mechanical properties of the EDR-1 and EDR-2 coded travertines were greatly influenced by accelerated weathering tests. The EDR-3 coded travertine were lesser influenced by accelerated weathering tests due to a relatively less porous structure and less stable organic residue. For this reason, EDR-1 and EDR-2 coded travertines are certainly not suitable for the armourstone material, while the EDR-3 coded travertine are more stable. However, due to the heterogeneous nature of travertines, specimens should be carefully selected when using travertines as armourstone material.

Keywords: Lake Van; armourstone; durability; lithotypes; travertine
Durability assessment of the Urla limestone (İzmir) in Western Turkey

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Urla limestone has been used extensively as construction stone on the outside of old and new buildings since historical times, but their material properties and durability are not well known. The purpose of this study is to determine durability of Urla limestone by evaluating petrographical, chemical and physico-mechanical properties. Our studies in Urla district show that limestones are not produced from an existing quarry, but optionally obtained from outcrops and construction foundations exposed in places. The limestone samples were obtained from excavation of a foundation. The limestones studied are classified as three groups (white, yellow, gray) according to their fresh surface color. Accelerated weathering tests such as MgSO4 salt crystallization, freezing-thawing and wetting-drying were conducted on the Urla limestone samples to assess their durability. Also, the durability of Urla limestone evaluated by determining its saturation coefficient, average pore diameter, wet to dry strength ratio, static rock durability index and slake durability indices. Urla limestones are classified to be moderately to high durable stone based on the test results of different durability assessment methods.

Keywords: Urla limestone; durability; accelerated weathering tests
Investigation of anisotropic properties of black marble in İzmir-Selçuk Belevi, Western Turkey

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In this study, laboratory works were carried out on rock samples obtained from black marbles in marble quarry which is located 2 kilometers north of Belevi Village and 1 kilometer east of İzmir-Aydın Highway in Selçuk district of İzmir province. The quarry is currently operated by Aydın Linyit Mining and Mermercilik A.Ş. while it was previously operated by Torbalı Vocational School.

Anisotropy in rocks indicates the change of strength and deformation properties of rocks due to the directional factory, microstructure and existing discontinuities.

The anisotropic properties and durability of the samples taken from the marble quarry in which İzmir-Selçuk Belevi black marbles were produced were investigated. Within this context, in the first stage of the study, the literature review of the marble quarry and its immediate surroundings was conducted, and the boundaries and general structure of the marble quarry were examined and undifferentiated rock samples were taken.

In the second stage of the study, the chemical, physical and mechanical properties of the black marbles were determined by the rock samples taken from the quarry and compared with the natural building stone standards at the Rock Mechanics Laboratory of the Dokuz Eylül University Geological Engineering Department. Samples were prepared for uniaxial compressive strength, Brazilian (indirect) tensile strength; point load strength index, impact resistance, and Böhme surface wear loss tests in three different directions. Saturated-dry uniaxial compressive strength ratio, salt crystallization, wetting-drying, thermal shock, freeze-thawing and warming-cooling tests were applied to the prepared samples to determine the stability of the rock against environmental decomposition effects in different directions.

Keywords: black marble; anisotropy; durability; Belevi; Turkey
Natural Stones have been extensively used in historical buildings, recently their use as geological material in different parts of engineering projects has increased with the developing industry and technology. It is important for the long-term behavior of engineering projects that the rocks used as geological materials are chosen correctly in order to provide appropriate services in the field of engineering projects for different uses and purposes.

Therefore, it is necessary to determine the durability of the fresh and weathered rocks in order to protect the original structure and texture against environmental influences from degradation and to provide proper service to the engineering structure in which it is used. For this purpose, accelerated weathering tests such as Freezing-Thawing, Salt Crystallization and Wetting-Drying, as well as different durability detection methods are used. One of the durability determination methods used to determine the durability of the rocks, is the Static Rock Durability Index (RDIs). However, recent scientific studies indicate that this method does not reflect actual results for some rock types.

In this study, the RDIs of 6 different rocks (3 Andesite and 3 Tuff rocks) that were collected from 5 different quarries in the city of Izmir (Turkey) were assessed. Rocks of different durability classes, RDIs were determined, detailed investigations and evaluations were made on this method. The investigation of the rock types and the causes of errors in which this method yields incorrect results, is considered to be important to make the necessary arrangements for the method to give accurate results.

**Keywords:** Static Rock Durability Index (RDIs); andesite; tuff, İzmir
The most important building materials of ancient cities are natural stones. The determination and classification of the rocktomic characteristics of the different types of natural stone / marble used as building material is extremely important. Aphrodisias, which is the subject of the study, is one of the most important ancient cities in the world. Aphrodisias is located in the Karacasu district of Aydın province and is the old city of Caria region. The aim of this study is to determine the lithological, macro, micro-petrographic and chemical characteristics of the ancient natural stone (s) / marble (s) commonly used in the ancient city of Aphrodisias. On the other hand, with these characteristics, a methodological classification is made in the form of origin group, natural stone genus, crystal size class and natural stone species. In addition, on the basis of this classification, it is aimed to examine the relationship between environmental geology and whether the natural stones used in the ancient city are autochthonous or allochthonous. In this study, besides the classification of origin and genus of natural stones, species identification was also made. In this definition, crystal size, color variability and structural properties of natural stone were taken into consideration. For detailed petrographic analysis, Olympus-Bx41TF polarizan microscope was used. Some known reference examples of crystalline marble were selected to classify the grain sizes of the crystalline marble grades. The grain size of the marbles was measured and crystal grain sizes were classified using computer image analysis method. In addition to the ICP-MS method, P-XRF (handheld portable -XRF / X-Ray Fluorescence Analyzers) was used as a new method for the chemical analyzes. Geological and marble formations in the vicinity of the ancient city of Aphrodisias were determined and the geological characteristics of the coordinated placed ancient and modern marble quarries were compared with the ancient city natural stones. Accordingly, 7 natural stone species were identified in the ancient city of Aphrodisias. All of the marble / natural stones are carbonate type, metamorphic origin group and crystalline marble genus. By using reference crystalline marbles, a grain size scale was created for these marbles, with grain sizes of 100-250 µm fine crystals, 250-1000 medium crystals, and large crystals larger than 1000 µm. According to this table, average grain size (AGS) of Aphrodisias crystalline marble species was determined between 213-575 µm. 3 types of marble are fine and 4 of them are medium crystalline marbles and no coarse crystalline species with AGS over 1000 µm have been identified. Within the environmental geology of the ancient city, there are many ancient and modern marble quarries in the distance of 1-2 km and 50-70 km bird flight. These marble quarries are in Permo-Carboniferous and Triassic-Jurassic-Cretaceous crystalline marble lithology within the core and cover series of Menderes Massif. When the detailed examination results of the marble / natural stone types used in the ancient city of Aphrodisias are evaluated, the coordinated ancient / modern marble quarry locations are around Palamutçuk, Yazır, Çamarası, Yeşilköy. These crystalline marbles of Jurassic-Cretaceous age, usually white, white-grayish-blackish, are located in the block production pool. The rich, high quality marble quarries near the ancient city of Aphrodisias indicate the environmental geological activity and the use of an autochthonous natural stone in the city.

**Keywords:** Aphrodisias ancient city; antique natural building stone type; crystalline marbles; portable-XRF; rocktomic properties
Scientific Session B.5

Fossil Energy Resources and Uranium/Thorium Deposits

Conveners:
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The formation of the eastern Mediterranean is largely dominated by the relative movement of the Arab-African plate and the Eurasian plate. These two blocks have converged since the end of Cretaceous to close the northern arm of the Tethys Ocean and form the Alpine chain between them. The southern boundary at the Alpine thrust front outcrops north of the Arabian platform, along the Taurus Mountains in eastern Turkey. More than 70% of the world’s oil and gas potential is in the Middle East (including the Eastern Mediterranean) and the Caspian and Black Sea regions. These provinces are the northern and southern sides of the Tethys Ocean. In this respect the Eastern Mediterranean and the greater part of the Middle East make up the southern segment of the Tethys Ocean since the disintegration of the Pangea about 200 Ma. Therefore, we must look up the oil and gas potentials of this region in the context of the plate tectonics and geodynamic evolution.

**Keywords:** Eastern Mediterranean; tectonic structure; plate tectonics; hydrocarbon province
First insights into peat-forming environments in Mozambican side of Maputaland, Mozambique

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The present study aims to provide an initial inventory of the physical, geochemical and petrographical features of organogenic sediments developing in the Maputaland part of Southern Mozambique. Fifty-nine organic and inorganic samples were collected from eleven cores up to 4.4 m deep, across several locations in Maputaland. The applied analytical techniques included proximate and ultimate analyses, pH and electrical conductivity (eC) measurements, coal-petrographical examination on intact samples, as well as mineralogical and geochemical determinations.

The ash yield ranges from 10.1 to 54.3% (on dry basis), while the maximum thickness of the organic sediments is 2.5 m. The sulphur content is high (up to 8.9%, db). The pH and eC values range from 1.9-8.1 and 33-2406.5 μS/cm, respectively. Maceral analysis reveals the predominance of the huminite group (57.6-78.6%, on mineral matter-free basis), followed by inertinite (<38.2%) and liptinite (<9.6%). A distinct prevalence is observed either in detrohuminite subgroup (up to 50.8%, mmf) or in telohuminite subgroup (up to 21.4%, mmf).

Quartz, clay minerals, pyrite, calcite, aragonite, bassanite, microcline and plagioclase are the major minerals in the studied samples. Additionally, halloysite and mix layers of illite-halloysite are identified, by analyzing the clay fraction of specific samples.

X-ray fluorescence (XRF) spectrometry reveals the predominance of SiO₂, with Fe₂O₃, Al₂O₃, CaO and MgO being the secondary major oxides; K₂O values range around 1%, whereas P₂O₅, Ti₂O, MnO and Na₂O are quite depleted (<1%). Regarding the trace elements, a significant enrichment in Ba, Zr and Sr is observed, whereas Sc, V, Cr, Co, Ni, Cu, Zn, Rb, Y, W, Pb, La range <100 ppm and Th, Ce, Hf <10 ppm.

The overall data indicates the development of peatlands in an interdunal environment, where peat and various organogenic facies were accumulating. The prevalence of detrohuminite subgroup (attrinite and densinite) points to intense mechanical decomposition of the plant material, which mainly derived from herbaceous vegetation. By applying coal-petrography indices it is suggested that peat was and continues accumulating mainly in reed mires, under mesotrophic and mostly anoxic conditions, with significant mineral matter influx; nevertheless, fluctuations of groundwater level, related probably to climatic conditions, resulted in periodically severe droughts and subsequent fires, during which peat surface was exposed to oxidation, as the enrichment in inertinite indicates.

Keywords: geochemistry; maceral; mineralogy; mire; peatland; peat-petrography
Peatification studies applying Organic Petrography: the case of Philippi peat, Macedonia, Northern Greece

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The geological study of modern peat-forming environments significantly contributes to the understanding of the coal-forming conditions in palaeomires. Among the major factors controlling the type of organic sedimentary rocks is the peat-forming vegetation, as well as the peatification or early-coalification pathways of the decayed plant debris.

Philippi peatland located in Eastern Macedonia, N. Greece, hosts a continuous organic/inorganic sedimentary sequence exceeding 200 m in thickness, which makes it a unique profile to study the early coalification features. This study focuses on the petrographic features of the upper parts of the peat profile, and particularly on the study under the microscope of the humification and gelification processes.

The upper most part of the peatland up to a depth of 15 m consists mainly of well-humified, Late Glacial-Holocene peat intercalating with thin layers of limnic sediments such as detrital and calcareous mud, and clay; peat derived mainly from Cyperaceae, namely Cladium mariscus and various Carex species.

Micropetrographic observation under white reflected light revealed that peat is composed mainly of well-humified tissues (stems, roots and leaves) of herbaceous plants, which are surrounded by a fine-grained groundmass of plant debris and porous gel particles (in form of humic colloids). The primary cell structure of the humified plant tissues is occasionally preserved, although the plant tissues are subjected to intense decomposition, compaction, and thus, deformation. The organic constituents appear in most samples with low relief, porous texture and low reflectance (dark grey colours), while by increasing depth, a slightly increase in relief and reflectance (light grey colours) and a denser texture are observed.

Under blue light excitation, the humic substances display a weak brown fluorescence, which decreases during the impregnation of humified tissues with gel colloids. The waxy and resinous organic compounds, on the contrary, display intense fluorescence colours.

In terms of organic petrology, peatification is developing in two stages: (i) humification precedes, under which the red internal reflections of cellulose remnants in plant tissues are gradually reduced, whereas the tissues become brown-grey under incident white light; the outcome is that cell walls (sensu pre-textinite) are converting to textinite A; and (ii) gelification, during which humic colloids produced from the hydrolysis of the cell walls, gradually fill in the intercellular space; the outcome is the formation of textinite B and subsequently, ulminite. Fluorescence intensity is gradually reduced from intense yellow in the pre-textinite to brown-black in textinite B.

This study proves that classical coal-petrography examination of peat, although imposing challenges in sample preparation, is a significant tool to elucidate the peatification processes.

Keywords: coalification; humification; maceral; gelification; Philippi
Maturation trends within the Oligocene Pindos Foreland in Western Greece

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The geodynamic evolution of Western Greece and particularly of Ionian Geotectonic Unit acquired significant research interest during the last decade, as a very promising oil-play field. Within this context, the research both onshore and offshore is focused on defining stratigraphical correlations, as well as on identifying potential source rocks and assessing their maturation trends. Till recent, the main analytical techniques included geochemical analyses and only in minor cases organic petrographical data was used.

In this study, coal and carbonaceous facies deposited within the flysch sequence of the Pindos foreland basin, were examined by means of organic petrographical and mineralogical methods in order to assess the lithologies, types of the contained organic matter and the maturation stage. Samples represent a wide range of sedimentary facies with variable organic matter content, as the total organic carbon content ranges between 0.3 to 63 wt.% (on dry basis). The studied lithologies represent in situ deposited thin coal layers and/or lenses, and a series of clastic sedimentary strata ranging from shales to carbonaceous siltstones, marlstones and sandstones.

The mineralogical data confirms the detrital nature of the contained mineral matter in the studied samples; silicates in form of quartz, K-feldspars, mixed-layer clays, chlorite and smectite are the predominant mineral facies, whereas authigenic minerals like calcite and pyrite occur subordinately.

In terms of organic matter type, maceral analysis reveals the predominance of huminite group in the coal and carbonaceous facies, proving the terrestrial depositional setting for these strata, whereas the amount of liptinite group macerals increases slightly in the shales and argillaceous sedimentary rocks. Additionally, solid bitumens were identified in several samples.

Vitrinite reflectance values range between 0.37 to 0.65%; however, VR values below 0.45% were measured in slightly weathered samples and are not indicative of the rank. The obtained values from fresh samples indicate a range of maturation from the early-subbituminous to the bituminous stage in terms of coal rank, or immature to early mature in terms of petroleum maturation. Additionally, the identification of solid bitumens in some of the carbonaceous rocks and shales reveal the formation of hydrocarbons, although their origin is yet to be defined.

The overall data of this study shows that during the Oligocene in Pindos Foreland peat-forming conditions were locally established for short periods, providing thin coal layers. Moreover, the studied carbonaceous rocks and the shales contain mainly terrigenous organic matter and minor solid bitumens. Nevertheless, further studies are required in order to define the source of the identified solid bitumens. In terms of maturation the data points to an immature up to early mature stage.

Keywords: Ionian Zone; maceral; mineralogical features; solid bitumens; vitrinite reflectance.
The Turkish Cenozoic Coals: A review of coal petrology, mineralogy and geochemistry

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Suitable conditions for peat accumulation were developed in Turkish territory due to optimal climatic conditions and regional tectonic activity during Cenozoic. The telohuminite macerals are the dominant sub-group, whereas liptinite and inertinite contents are variable. The XRD-identified minerals in Turkish Cenozoic coals are generally quartz, clay minerals, calcite, pyrite, gypsum, feldspars, and rarely aragonite and zeolites. Furthermore, several accessory minerals such as chromite and sphalerite, are also reported through SEM-EDX studies. The enriched elements in Turkish Cenozoic coals are As, B, Cr, Ni, Mo, V and U. The clay minerals and chromite generally point to clastic input from adjacent areas into palaeomires. The input could also cause As, B, Cr, Ni and U enrichments. Nevertheless, kaolinite and zeolites are formed within palaeomires from altered volcanic inputs. The syngenetic carbonate minerals and pyrites are related to Ca- and sulphate-rich aquifer supply and anoxic conditions within the palaeomires. Latter could also explain U and Mo enrichments. Furthermore, influence of epigenetic hydrothermal solutions could also result in cleat/fracture infilling of As-bearing sulphide minerals and elevated huminite/vitrinite reflectance values due to heat up. Overall, mineralogical and elemental compositions of Turkish Cenozoic coals are mostly controlled by mainly syngenetic factors and in some cases only by epigenetic factors.

Keywords: Turkey; Cenozoic; coal deposit
Petrophysical properties determination of the Ordovician (Hırmatian) siliciclastic of Bedinan Formation with geophysical methods (well logs and seismic) around Bismil SE of Diyarbakır, Southeast Anatolia

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Hydrocarbon plays were discovered in Ordovician (Hırmatian) siliciclastics (Bedinan Formation) around Bismil, Diyarbakır. The Bedinan Formation consists of mainly sandstone-siltstone and shale in the play areas. In the sections obtained from 3D seismic data, structural traps were observed being developed in a re-activated normal fault system. The source rock of the petroleum system is the Dadaş Formation (Silurian) located at foot wall, and the hydrocarbon migration pathway to the Bedinan siliciclastic reservoir in the hanging wall, is directly related to the normal fault system. Several exploration wells have been completed as hydrocarbon discovery in foot wall of the normal fault; the sandstone reservoir thickness is ranging from 6 to 8 m. In these wells, the average porosity and the water saturation values are 18% and 30%, respectively. The permeability value, determined in the core from one of these wells, is 6 mD. It was also determined that sandstone levels were affected by clays from γ-ray logs, and porosity values were partially decreased in parts where clay content increased. The resistivity, γ-ray and porosity logs indicate that the lateral and vertical facies characteristics and reservoir rock quality change between the wells in the Bedinan sandstones. The lithology of the Bedinan Formation is transformed into a very fine grained sandstone-siltstone towards the north of the hydrocarbon explored area and some wells drilled in the structural traps in this area, are of poor quality or even reveal tight reservoirs. However, after directional drilling and some workover operations of these tight sandstone facies, hydrocarbon production could be possible.

Based on the well log data and the seismic studies, it can be concluded that the quality of the reservoir rock of Bedinan Formation decreases from south to north in the study area, and changes in the control of local reactivated normal fault system in the structural traps. While the Bedinan siliciclastics have unconventional potential in the northern part, it could be conventional and/or unconventional production from the Bedinan siliciclastics in the study area.

Keywords: Diyarbakır; Bismil; Bedinan Formation; hydrocarbon; Turkey
During Neogene, several sedimentary basins formed and volcanic activity took place in western Anatolia due to regional tectonic activity. As a result, basinal infillings of these Neogene basins are mainly composed of lacustrine, alluvial and fluvial sediments, which host mineable coal seams and borate deposits. The Dursunbey Basin is a typical example for Neogene sedimentary basins in western Anatolia; it hosts mineable coal seam of Miocene age. The coal-bearing sequence consists of lacustrine carbonates and fluvial sediments. Furthermore, altered tuff layers are also identified within this sequence. This study focuses on elemental compositions, as well as on mineralogical and petrographic composition of working coal seam in Dursunbey coalfield. A total of twenty-four profile coal samples were taken from a 9.7-m-thick coal seam in the north-eastern parts of the coalfield. Matrix lithotypes are commonly identified in the upper part and mineral-rich lithotypes are more common in the low part of the coal seam. The proximate and ultimate analyses show that on dry basis ash yields (6.3-73.0%), volatile matter (22.7-43.8%), C (27.2-66.2%) and total S contents (2.0-6.7%), and gross calorific values (5.1-28.1 MJ/kg) are variable. The identified minerals by X-ray powder diffraction (XRD) are clay minerals, quartz, feldspars, pyrite, calcite, and gypsum. The SEM-EDX data shows that clay minerals are generally associated with other minerals (e.g. quartz and feldspars), while framboidal pyrites are commonly identified. Huminite group macerals are dominant, whereas liptinite and inertinite contents are low. The elemental composition on whole-coal basis, which was determined by ICP-AES and ICP-MS analyses, show that Cr, Ni, As and Cs are enriched (10>concentration coefficient (CC) >5); slightly enriched elements (5>CC>2) are Sc, V, Cu, Zn, Mo, Sn and U in comparison with the Clarke values of the world low-rank coals. The majority of minor and trace elements in the studied samples display moderate (0.50≥r≥0.70) to strong (r≥0.70) positive correlation with ash yields, Al, K, and Mg. These correlations indicated aluminosilicate affinity (clay mineral and feldspar) for minor and trace elements in the studied samples. Considering the presence of metamorphic and ophiolitic rocks in the basement and the adjacent areas, clastic input into the palaeomire seems controlling aluminosilicate-affiliated elements. Nevertheless, V, As, Mo, Sb, and U display moderate positive correlation with total S contents, which could imply a sulphide affinity for these elements. In agreement with this assumption, As and Ni are detected in framboidal pyrite crystals by SEM-EDX. Additionally, the common presence of framboidal pyrite crystals in entire seam implies the development of anoxic conditions within the palaeomire which, in turn, explains the positive correlations among Mo, U and total S contents. Consequently, the sediment input from adjacent areas and the redox conditions within the palaeomire controlled elemental and mineralogical compositions of the studied coal seam.

Keywords: coal; Miocene; nickel; arsenic; Turkey
Scientific Session C.1

Air, Water and Soil Pollution

Conveners:
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Distribution and source of aliphatic hydrocarbons in surface sediments of the Edremit Bay (Aegean Sea)

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The distribution and source of aliphatic hydrocarbon levels were investigated in surface sediments of Edremit Bay (Aegean Sea) in Spring and Autumn 2015. 14 sediments were collected in each season (total 28).

Sediments were freeze-dried, sieved, passed for clean-up column and analyzed for aliphatic hydrocarbon analysis (nC10-nC32, Pristane and Phytane) with Gas Chromatography-Mass Spectrometry. Organic carbon and grain sizes analyses were also performed. Plymouth Routines in Multivariate Ecological Research (PRIMER) statistical analysis and diagnostic ratios were used to evaluate the source of aliphatic hydrocarbons in Edremit Bay sediments.

Total aliphatic hydrocarbon concentrations were found as 77-2297 and 6-1358 ng/g (dry weight) in Spring and Autumn, respectively. Total aliphatic hydrocarbons correlated with silt and clay while no correlation observed with organic carbon and sand content. Statistical analyses and diagnostic ratios have shown that sediments at southern part of Edremit Bay were marine originated in general while the remaining parts were terrestrial. Total aliphatic hydrocarbon levels were relatively higher in Spring if compared to Autumn. Overall, the sediments were found unpolluted considering the total aliphatic hydrocarbon levels.

Keywords: aliphatic hydrocarbons; sediment; sources; Edremit Bay; Aegean Sea
In-situ indoor gamma dose rates at Nusratlı and Ahmetçe villages
(Ayvacık/Çanakkale/Turkey)

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This study deals with in-situ indoor gamma dose rates measured in Nusratlı and Ahmetçe villages in the region of Arklı uranium mineralization. The measurements were held in 79 dwellings (15 from Nusratlı and 64 from Ahmetçe). The dwellings are mostly wall-typed and single-storied and built from andesitic and dacitic-rhyolitic tuffaceous (Arklı tuff) units of Behram volcanics. Mud wall plasters made from local sedimentary material were used more often than cement plasters. Eberline brand portable type ESP-2 model Na (I) scintillation probe connected detector was used during the measurements. For the evaluations of the measurements, statistical tools are used.

The measured gamma dose rates in the study area were ranging from 104 to 400 nGy/h and 139 nGy/h to 409 nGy/h for Ahmetçe and Nusratlı villages, respectively. Because of the used local rocks as building materials, the measured values in both villages were high. The median gamma dose rate values are 3 and 3.3 times higher than that of the world average (84 nGy/h), respectively.

This research was supported by Scientific Research Projects Programme [BAP/ 41483/ 2018/ MGA] of Istanbul Technical University in 2019.

Keywords: Indoor gamma dose rate, Building materials, Uranium mineralisation area
Determination of Groundwater Budget Using GIS Integrated with Groundwater Level Data for the Alluvial Aquifer in the Alaşehir Basin, Manisa

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It is very hard to determine the groundwater budget for an aquifer with respect to the hydrogeological study. Reliable, measurable and enforceable hydrological budget components must be used for determination of the groundwater potential (GWP) in an aquifer in great river basins. In this perspective, a multi-level study was applied to determine the groundwater budget parameters in the alluvial aquifer in the Alaşehir plain, Manisa. In this study, the groundwater budget has been estimated using the monthly groundwater level measurements employing a Geographical Information System (GIS). The groundwater budget parameters calculated based on the monthly groundwater level were illustrated on digital maps in the GIS environment.

Keywords: alluvial aquifer; groundwater level; groundwater budget parameters
Effects of operation mode on the efficiency of upflow anaerobic filter treating baker’s yeast industry’s waste water

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Baker’s yeast industry is one of the largest fermentation industries. It is the most economical cell production process. The annual amount of bread yeast produced in the world is about 2-2.5 million tons. Approximately 20% of this is produced in our country. A large part of this ratio is manufactured in factories located in Turkey's western cities. Therefore, the treatment of yeast industry wastewater is important in terms of reducing environmental pressures on water resources.

In the laboratory-scale experiments, treatment of synthetic wastewater containing molasses, representing effluent wastewater of baker’s yeast industry, has been investigated by using an upflow anaerobic filter reactor (UAF). Experimental studies were examined at different organic loading rates varied between 0.5 and 2.0 kg COD/m³/day for hydraulic retention time (HRT) of 2 days at temperature range of 37±1°C. Effects of the operation mode, continuous and semi-continuous, are investigated in terms of removal efficiencies of chemical oxygen demand (COD), total solids (TS) and total volatile solids (TVS). Increasing organic loading rates were negatively affected the reactor performances from UAF in both operation conditions. The highest COD (85%), TS (76 %) and TVS (71%) removal efficiencies were achieved in continuous mode at 0.5 kg COD/m³.day.

A Box–Behnken design was also applied, and the response (COD removal) was maximized. The model is well fitted and model validation showed a 96 % fit between the theoretical and experimental ones.

Keywords: upflow anaerobic filter; baker’s yeast industry; waste water; treatment; statistical optimization
Distribution and mobility of arsenic and heavy metals in the soils close to the mining site of Grammatiko, North Attica (Greece)

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The topsoils of Grammatiko area, NE Attica have been affected by historical mining of Fe-oxide ore which led to the production of large quantities of metal-rich wastes that were dispersed around the mine area. Abandoned waste rock piles are distributed along the main strike of the ore body. Preliminary bulk analysis of twenty samples from the topsoils in the study area showed high total As concentration i.e. ranging from 320 ppm to 650 ppm for the 25% of the samples, as well as high total Mn and Zn concentration. Total As concentration is well above the upper guideline value for residential soil use, of most European countries (EUR 22805 EN – 2007, JRC Report). The exposed Fe-oxide mineralization in open pits and the waste piles are subjected to weathering processes, whereas they are potential sources of contamination of the local soils and water bodies. The leachability of arsenic is assessed by standard water leaching test (EN 12457) and its chemical fractions are determined by using Sequential Extraction method (Wenzel method) in combination with mineralogical analysis, in the samples with the highest As concentration. The new geochemical data resulted by this research will be presented as a series of multipurpose geochemical maps in order to facilitate the potential risk assessment regarding the surrounding terrestrial and aquatic ecosystem.

Keywords: Fe-Mn mine; environmental characterization; arsenic dispersion; sequential extraction; soil contamination
Milas region, including Turkey's valuable various geological ages' marble limestone and marble quarries is a significant carbonate platform. There are several discharged karstic springs around Milas district. Water samples were taken not only from the karstic springs but also from some streams, drilling wells and surface waters as lagoon and lake. Karstic springs (Icme, Savran and Ekinambari) are short of 7-12 km inland from the Aegean Sea. Temperatures of the karstic springs range between 17.3 and 20.1 °C and the pH value is 7.5 approximately. The mean electrical conductivity (EC) value is 17310 µS/cm in the 3 main karstic springs. In contrast, EC values of the surface waters are vary between 276 and 4030 µS/cm. According to IAH water facies classification, all of the waters are Na-Cl water type, except stream water samples taken far away from the sea. Na and Cl concentrations of the samples support the water facies types with 482-11450 mg/l and 1500-19600mg/l, respectively. Otherwise, stream waters are Ca-Na-HCO$_3$, Ca-Na-Mg-HCO$_3$-Cl-SO$_4$ water types. Cations and anions are showing perfect correlation with 0.98 correlation co-efficient mean value. Lithium which is minor ion and the marine effect indicator shows good correlation with Cl (correlation co-efficient = 0.80). Delta O-18 and delta D contents of the samples respectively ranged from -6.00 to 0.50 per mille and from -29.1 to 2.1per mille, respectively. In general, waters are plotted on the seawater mixing line. According to the relationship between delta O-18 and Cl, the source of salinity in Icme and Ekinambari springs are related with “Seawater Mixing”, and in Savran spring is related with “Dissolution of Salts-Leaching” processes.

Keywords: hydrogeochemistry, karstic springs, salinization, Milas, Turkey
Investigation of child parks in İzmir using magnetic susceptibility and radiometric methods

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Pollution of soils is significantly reducing environmental quality and affecting human health. As a condition for effective protection and remediation actions, the screening and detection of soil and sediment pollution has become increasingly important. The pollutants of most cases are usually heavy metals, organic contaminants and agricultural applications such as chemical fertilizers, pesticides and hormones. Also ionizing radiation and non-ionizing electromagnetic field are very harmful for human health. The aim of this study is to trace the distribution and concentration of both contaminants in soils and radiation effect around children’s playgrounds in city of İzmir. Magnetic susceptibility, non-ionizing electromagnetic radiation and ionizing radiation measurements were carried out at 25 different sites. Nine of the sites were in Bornova, 8 in Karşıyaka and 8 in Konak districts. Radiation and magnetic susceptibility values were collected in and around the sites. As a result, it was determined that all of the sites were safe about ionizing radiation. Electromagnetic field strength values were above the safety limits at 17 sites and magnetic susceptibility values were above the average rates at 12 sites. The reasons which cause high susceptibility readings should be investigated with geochemical methods in order to define the heavy metals. Also the electromagnetic field generators, usually transformers and high voltage lines, should be removed from these locations.

Keywords: electromagnetic field; human health; magnetic susceptibility; radiation
Scientific Session C.2

Engineering Geology

Conveners:
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Use of waste glass as an additive material in stabilization of swelling clays

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Volumetric changes in swelling clays can cause significant damages in low-rise buildings, roads, pipelines. In many studies, cement, lime, fly ash, bitumen etc. were used as additives in order to stabilize clayey soils and hence minimize the damage. The number of the studies using waste glass as an additive in the stabilization process is, however, limited. In this study, the use of waste glass alone and with alkaline additives (CaO and NaOH) in stabilization of Ankara Clay, which has high swelling potential, was investigated. In order to optimize the percentage of waste glass that would decrease swelling but at the same time increase strength, varying percentages (5, 10, 15, 25 and 30%) of waste glass powder were added to the Ankara Clay, and the change in free swelling index, shear strength parameters and uniaxial compressive strength of the clay were determined. As the glass amount increased free swelling index of the samples decreased as expected. Shear strength parameters, however, decreased when 25% glass was added. It has been observed that when waste glass was used alone, its effect was limited. Better results were obtained when waste glass powder and CaO were used together in stabilization process. In fact, 15% glass powder + 5% CaO added samples showed 291% increase in the uniaxial compressive strength at the end of 14 days of curing period. It was also determined that in samples that were prepared with CaO in addition to the glass powder, the free swelling index decreased by 73%.

The results of XRD analysis of the samples showed no significant change in the mineralogical composition of the soils after stabilization. In SEM analysis, however, denser structures were observed in the stabilized samples.

Keywords: Ankara clay; waste glass powder; stabilization; free swelling index; uniaxial compressive strength
The influence of anisotropy on andesite rock strength in Bornova district İzmir Turkey.

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The city of İzmir(Turkey) lies on geological formations characterized by sedimentary, metamorphic and volcanic rocks. The volcanic rocks in the region originate from the late Miocene volcanism that was active in the region with the volcanic rock are of: andesitic lavas, autocracies, basaltic andesite, and andesitic agglomerates. The andesite rocks of this region have been an important building material in İzmir including its surrounding ancient Roman cities like Ephesus. The city has seen an enormous population increase hence; a number of major engineering structures are under construction involving large slope cuts, tunnels and shafts in the city. Therefore, the short-term and long-term engineering behaviours of these rocks are very important in terms of the excavation and the stability of these structures.

Therefore, several of their rock parameters were assessed to investigate its performance. However, rock strength has represented one of the key parameters, which is determined by Uniaxial Compressive Strength. Unfortunately rock anisotropic behaviour significantly influence UCS testing and interpretation of rock strength. The purpose of this study is to determine anisotropy, assess their strength in respective to directional orientation and to further investigate the durability of andesite rocks. Hence, field assessments and several laboratory tests (physical and mechanical properties and durability tests) were conducted on the rock samples.

**Keywords:** anisotropy; rock strength; andesite; İzmir
This study investigates the stability of a rock slope which is prone to discontinuity controlled failure with continuum and discontinuum modelling. Continuum modelling was performed by finite element method (FEM) via Phase2 software. On the other hand, discontinuum modelling was carried out using discrete element method (DEM) by UDEC software. Both FEM and DEM were used to simulate the slope in an open pit albite mine in Çine, Aydın. In the pit, the rock units comprise of dominantly fractured, weathered orthogneiss, ore body and mica zones along contacts and/or as lenses in quartzite veins. Block formation in the cut slope is provided by nearly perpendicular intersection of joints with foliation planes. The foliation planes oriented approximately parallel to the overall slope face which do not allow overall slope sliding kinematically. However, during excavations at the toe of the slope for mining operations, stress due to gravitational forces is transferred from upslope to the toe of the slope. Foliations play a key role in transferring the gravitational force. Consequently, the rock mass becomes more fractured at the toe of the slope and shear displacements tend to occur at the toe. After a while, a severe rainfall period together with the shear stress accumulation caused a large slope instability which developed at a slope angle of 25°. The slope is sensitive to variations in water table level. The main objective is to compare the factor of safety values and failure surfaces obtained from FEM and DEM models. In addition, both methods were discussed as which one is more realistic approach considering the recently occurred landslide. In-situ tilt tests were carried out to determine shear strength of discontinuity surfaces. Some physico-mechanical properties such as unit weight, cohesion, internal friction angle, elastic modulus and Poisson’s ratio of orthogneiss and orebody were measured in the laboratory. The discontinuities and the rock materials were considered to be obeying Mohr-Coulomb Criterion with elastic-perfectly plastic behaviour. With the given set of parameters, FEM captured a failure mechanism as sliding along foliation planes and shear failures at the toe. On the other hand, DEM yielded unconservative results in terms of FOS values. Furthermore, the displacement vectors have generally indicated slides at bench scale. It was stated that FEM and DEM have several advantages and disadvantages over each other.

**Keywords:** discrete element method; factor of safety; failure surface; finite element method; rock slope
Assessment of waters of Euphrates – Tigris basin

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Euphrates – Tigris basin is a huge basin in South Eastern Turkey. This basin has high topography in the North (2000 m) and drop to low 500 m in the South. The basin area is 180.000 km². Euphrates – Tigris rivers carrys 56.000 m²/s water in the basin in addition to several tributaries in the area. Vast mesopotomian plain is is formed by the erosion of these rivers and their tributaries in Syria and Iraq. Turkey has been building dams in the Euphrates – Tigris basin since, 1973 Keban Dam construction. Even though, most of the dams built in the Euphrates – Tigris basin are energy producing type not causing major decrease in flow quantity r to downstream countries, they have been objected by the Syria and Iraq.

Turkey has not ratified the 1977-UN convention on the law of the non-navigational use of international watercourse. This gives a way to develop the water of the Euphrates – Tigris basin as she wants. Thus, South Anatolian Project (GAP) is being develop after UN approval. During the construction of Keban Dam releasing of a minimum of 350 m²/ s has been the condition was set from the Euphrates river by the American Credit Company. Even if this is not openly stated it is (1/3) flow quantity of the Euphrates river. Turkey has increared this amount to 400m later to /500 m/s. But, the Syria /Iraq demanded 700 m²2/s in the tripathiat meetings. Studies made by German showed that more than 700 m²/s water flows from Turkey at Jarabulus. Additionally Syria and Iraq have shared the water of Euphrates between them at 45% Syria and 58% Iraq. This is an odd way of sharing. 42% of 700m²/s is almost equal to 58% of 500m²/s flow which is about 290 - 4 m/s. This indicates that Syria and Iraq have decided to share the Euphrates rivers water equially without any declearing the flow record at Jarabulus. Turkey declleared officially releasing 500m²/s downstream from Euphrates to Syria without taking into account flow of tributries and the groundwater. Since the whole waters of Euphrates – Tigris basin water flows to Mesopotia basin, there should not be any ground for water dispute of Euphrates – Tigris basin.

Another disputed issue is pollution of Euphrates – Tigris basin waters. One of the pollution type is, due to melting of geological formations. The surface water pollutions due to use of fertilizers in irrigation and industrial use. However, claims are often made without reliable chemical analysis. Turkey is trying to manage the rivers according to Helsinki rules for water pollution. Additional, extra water requirement from Euphrates – Tigris rivers by Syria and Iraq should be given by selling at as it is done in South Africa where Leshoto is selling its water to South Africa Government.

Keywords: euphrates; Tigris; Mesopotamia; UN-1977 convention; Helsinki Rules
Lessons from Eğridere Landslide - 2019

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A medium size land sliding has occurred on 13th February in North of Eğridere village, North of Bornova Brough of İzmir Metropolitan Municipality. Land slide occurred in colluvium an area which has been open to development after the official site investigation contracted by the Metropolitan Municipality of İzmir. The site investigation has been designed and controlled by the Municipality Engineers. The suitability of the report has been approved by the Chambers of Geological Engineers and Geophysical Engineers and the İzmir offices of the Environmental and Urbanization Ministry. The report classified the land slided zone and its surrounding area as precautionary zone for development. Then, the İzmir Metropolitan Municipality has prepared development plan for the area. Land owners have arranged their land into hobby gardens by cutting trees and plants. The sliding has occurred in the tree cleared area following heavy rainfall in the area effecting the nearby structures of 9.24 hectare i.e. one story buildings and barns, but not effecting tree covered cemetery. The landslided area has been declared as a hazard zone by the government including 30 houses and 15 barns and covering an area of 248,000 m². This area has been closed to development and suggested to be used as recreation area after necessary arrangements. The study of the events leading to landsliding indicates that:

a) The design, control and interpretation of the site investigation is not properly done to identify possible landsliding in the area.
b) The prepared site investigation report has been approved as suitable for development area based on surficial investigation.
c) The Metropolitan Municipality has opened the 4.5 hectare area for development without any preconditions.

This case history clearly shows that the site investigation report has not been done properly from designing, full fulfillment and approval stages without considering the probable landslide occurrence. The landslide damage of land and its value loss is not expect to be compensated by the government. This would give right to people who’s land have been affected by such natural hazard after full scale site investigation to sue the responsible authorities for loss of their land. Additionally, every landslide, cannot be declared official disaster zone. Thus, it is recommended to have an insurance scheme to compensate the unidentified damages to the environment. It is also recommended that control and interpretation of site investigation reports be done by an independent authority just as building inspection companies to minimize the ground failure and damage.

Additionally, to improve the quality of site investigations quota should be brought to the firms on the number of site investigation reports they are to prepare in a month/year etc.

Keywords: Eğridere; landslide; site investigation; tree clearance; disaster; heavy rain fall
Effect of Disturbed Zone Depth on Slope Stability Analysis: a Case Study from Western Black Sea Region (Turkey)

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Rocks in road cuts are affected by weathering, excavation and tectonic activities. The weak rocks especially disturbed by tectonic activities lose their strength over the years due to excavation and weathering. One of the most important parts to consider here is the damage caused by the type of excavation to the rock mass. In addition, weathering reduces the rock strength towards inside of the slope through discontinuities. In this study, the effects of weathering and excavation on rock strength parameters have been investigated by using twenty rock slopes located in Western Black Sea region of Turkey. Strength parameters and index rock properties were investigated in laboratory extensively. Detailed discontinuity analyses were done for all cut slopes by scan line surveys in the field. The intact rock and rock mass properties were determined for both weathered and relatively fresh zones at the cut slopes. The evaluations of disturbance depths were made according to strength differences and visual estimations of weathering degrees. According to these investigations the effects of weathering and excavation were found to be changing between 10 and 50 cm for the studied cut slopes within 5 years of lifetime. Throughout the study area the disturbance factor was assigned only to weathered zones to evaluate the stability of the slopes. Also the slope stability analyses were done by assigning the disturbance factor to different depths. It is found that the field observations are matching with the stability assessments considering the disturbed zone depths. Fresh and weathered rock mass properties were evaluated by Geological Strength Index (GSI) and the ratio between global rock mass and intact rock strength. It has been obtained that fresh and weathered rock mass properties are coherent with the Hoek Brown criterion on disturbance factor. Results indicate that the surfaces of the slopes reveal different degrees of disturbances and towards inside effects of weathering and excavation decrease. As a result, it is noted that the disturbance factor value should be used only for a certain depth and rest of the slope should be assigned as zero disturbance.

Keywords: disturbance factor; excavation; rock strength; slope stability; weathering
Influence of physico-mechanical properties on the performance of blasting and its independence case MEFTEH quarry (Algeria)

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The dependence of characteristics of the MEFTEH quarry limestone rock mass, with parameters of the drill mesh and its influence on the performance of the blasting work, was studied and analyzed with a linear regression for the engineering applications. This study is based on the collection of real data by sampling carefully established and taken in the field. These samples were tested in the laboratory for the determination of the different properties of rock resistances. This study has highlighted a relationship of dependence of mechanical properties and the drilling yield according to the different resistances of simple compression, traction and point load.

Keywords: correlation; mechanical properties; physical properties; rock mass; sampling
Hydro-geochemical characterization of a multilayer aquifer, in Northeastern Algeria

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The Complexe Terminale and the Continental Intercalaire waters are belonged to the Northern Western Sahara Aquifer systems, with a regional extension. In Tolga zone, underground waters are contained by the two systems of the Sahara, it is characterized by an arid climate and a vast agricultural activation, which suppose the subject of the quality and the piezometric level evolution.

This study represents the chemical characterization of the different levels in our study area. It represents the results of chemical analyses (Ca\(^{2+}\), Mg\(^{2+}\), Na\(^{+}\), K\(^{+}\), Cl\(^{−}\), SO\(_{4}^{2−}\), HCO\(_{3}^{−}\) and NO\(_{3}^{−}\)) of 55 samples from wells and boreholes collecting the different aquifer levels.

Groundwater represents a predominantly chlorinated calcium and magnesium character due to the dominance of evaporitic and lagoon formations at different levels. The waters of the surface table are highly contaminated with mineral salts, and represent a migration towards the sulphated pole, when the deepest water tables are fewer charged with mineral salts, those waters of the lower Eocene and the Turonian aquifer waters. These waters, in particular the quaternary waters are hard with a high salinity and poses a distinct danger for plants.

**Keywords**: Tolga oasis; multilayer aquifer; water quality
The purpose of this study is to assess the stability conditions of rock mass collapse phenomena (rockfalls and rocktopples) affecting Kaliakra Cape, NE Bulgaria, which is visited by many tourists and is a subject to archaeological research. Engineering geological assessment of the rock mass has been made through the internationally accepted criteria of rock mass classifications. The results of the RMR classification characterize the rock mass as fair to very poor, and according to the SMR it is poor to very poor. The geophysical studies (electric resistivity tomography and magnetometer survey) showed a complicated composition in depth, characterized by karst, water saturated bodies and subparallel fault surfaces. The shape, dimensions, and orientation of five selected large rock blocks have been determined to assess their state of stability, based on the data for main joint systems and the joint distances. Thus, a stability assessment using the stereographic projection of each block was carried out. In addition, we Murakami & Yanai (1987, 1989) approach for assessment of rolling and sliding stability of single blocks was also applied. It is estimated that the most of blocks are in a stable state but very close to the equilibrium position. However, seismic impact calculations show that the blocks will be unstable during seismic impact at a seismic acceleration to be PGA ≥0.526 m/s². Simulation calculations of falling and toppling rock blocks were also made in the direction of the tourist trail. The dimensions of the blocks are determined by in situ measurements (with the assumption of some deviations due to irregular shapes), their weight is based on data from the laboratory tests of typical samples. In the simulation calculations, a value of the elastic modulus to be E=17 GPa was accepted, the coefficient of restitution on the path of the falling block was assumed to be 0.35. For the purposes of the future countermeasures, calculations of the energy of falling and toppling rock blocks have been carried out. The highest values of energy are 14.6 kJ for a free fall and 22.2 kJ for toppling of the larger block No. 3. The stability calculations and simulations of falling and toppling blocks allowed recommendations to be given for necessary countermeasures, such as retaining walls and rockfall protection fences.

Keywords: slope stability; toppling; rockfall simulation; Kaliakra Cape
Scientific Session C.3

Engineering Geophysics: New Methods and Applications

Conveners:
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Dr. Çağlayan BALKAYA; Dr. Gökhan GÖKTÜRKLER
A contribution of ASTER and airborne geophysical data for evaluating mineralization potential in Dungash-Atud area, southeastern Desert, Egypt

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Dungash-Atud area, located in the southeastern Desert of Egypt, is intensively characterized by gold mineralization and associated mineral deposits. This interesting area of investigation was studied using detailed and integrated analysis and interpretation of remote sensing (ASTER), aeromagnetic and aerospectrometric data. From the ASTER analysis, the alteration imagery maps of different minerals including arsenopyrite, pyrite, chlorite etc. are obtained and classified, in addition to mafic and quartz index. Also, detailed knowledge about rock reclassification of rock units to different phases are determined using different techniques particularly older and younger granites. The processed and interpreted aeromagnetic data helped effectively for detection of the prevailing subsurface and near surface structural elements affecting the area, and checking favorable sites of mineralization. In addition, the spectrometric data; total-count (TC), potassium K%, equivalent uranium eU and equivalent thorium eTh as well as obtained ratio maps (eU/eTh, eU/K and eTh/K) and ternary radioelement composite images were analyzed and used to deduce the enriched sites of U and Th mineralization.

The integrated results of this study are guided and tied with pervious geological information, specially ancient and present gold mines and associated minerals. It gave clear clue about existing basic to ultrabasic parallel wide dykes injected within faults zone trending mainly parallel to the Red Sea rift tectonics (NW- direction). These intrusive long extended wide dykes are cutting across the whole investigated area with deep extension. Other faults and dykes, trending in NE direction are also found with some sense of lateral displacements reflecting shear zones. In addition, some existing gold mines in Dungash-Atud area are noticed to be associated with the some detected structural elements and rock affinity such as at G. El Aurf as an example. Hence, it is easy to recommend and follow other three sites that could have high potential of mineral deposits.

Keywords: ASTER; remote sensing; aeromagnetic; radiometric; ratio maps; Dungash-Atud
Global Optimization of Total Field Magnetic Anomalies Due to Fault Structures: Differential Evolution versus Particle Swarm Optimization

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Naturally inspired meta-heuristic optimization algorithms based on some stochastic procedures have attracted more attention during the last decade due to their capability in finding the optimal solution of the source parameters from the parameter space via a direct search. In this study, the solutions obtained through differential evolution algorithm, a rarely used meta-heuristic algorithm in geophysics, and particle swarm optimization which is one of the most used global optimization algorithms in geophysics have been compared using synthetic and real magnetic anomalies due to deep-seated fault structures. Real data application has been performed using an airborne total field magnetic anomaly observed over the Perth Basin (Australia). Applications have shown that although both algorithms provide close results, differential evolution algorithm yields slightly better solutions in terms of robustness, stability, computational cost and convergence characteristics.

Keywords: magnetic data; fault structures; global optimization
Global Optimization of Gravity Data of Basement Relief Through Differential Evolution: A Case from the Aegean Graben System, Western Anatolia, Turkey

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Gravity data inversion of basement relief of Aegean Graben System was achieved using differential evolution algorithm which is an efficient stochastic vector-based metaheuristic. Long wavelength anomalies due to both crustal and deeper effects were successfully removed from the complete Bouguer anomalies through a finite element method based on shape functions. Before the two-dimensional optimization, the mathematical nature of the inversion procedure was investigated by producing error some cost function topography maps. These maps indicated the resolvability of the model parameters, namely the thicknesses of the model blocks. Some profiles extracted from residual gravity anomaly map were used for the optimization and obtained results showed the general sediment thickness of the Aegean Graben system.

Keywords: differential evolution; gravity data; Aegean graben system
New insight on the North Anatolian Fault from multi-channel seismic reflection imagery in Adapazarı Basin, Eastern Marmara

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Approximately 1600 km long North Anatolian Fault (NAF) extends from Karlıova in the east of Turkey to Gulf of Saros in the Northern Aegean Sea quite parallely to the southern shores of Black Sea. Near Mudurnu, western part of the NAF splits into branches as north and south and the northern branch of the NAF reaches to the Sea of Marmara through Sapanca Lake and İzmit Bay. All parts of the NAF other than Marmara Fault in the west and Yedisu Fault in the east were ruptured as a result of a M>7 earthquake sequence beginning with 1912 Ganos earthquake, which took place in the western part of the Marmara Sea, and ending with 1999 İzmit (Mw = 7.4) and 1999 Düzce (Mw = 7.2) earthquakes. As a consequence of the 17 August 1999 İzmit Earthquake a surface rupture of approximately 145 km occurred between the Marmara Sea in the west and Düzce in the east. Even though the NAF was investigated in great detail especially after the mentioned Mw>7 earthquakes in the Sea of Marmara through the utilization of seismic reflection method by using wide range of penetration depths, investigations in the land areas of the east of the İzmit Gulf were mainly carried out by using geological and geodetic data. Therefore, in order to determine the geometry of the NAF at depth, in November 2018, within the context of TÜBİTAK-1001 Scientific Research Project (No: 117Y130), multi-channel seismic reflection data were collected along an approximately 1.3 km long line that crosses the NAF perpendicularly in the NE-SW direction near Ekinli village, which is located approximately 13.5 km to the southeast of Adapazarı. Collected multi-channel seismic reflection data was processed by using the Paradigm® ECHOS® (v15.5) seismic data processing software package in the ITU Geophysical Engineering Department, Nezihi Canitez Data Processing Laboratory. Followed processing steps can be listed mainly as defining the shot-receiver geometry, editing, filtering, gain application, CMP sorting, velocity analysis, stacking and migration. In order to strengthen the results related to the near-surface structures, as an addition to the seismic reflection data processing, seismic refraction tomography method was carried out by using SeisImager/2DTM program, through the utilization of first arrivals that are present in the collected multi-channel seismic reflection data. In the obtained final section of the multi-channel seismic reflection method, the region where the NAF is located can be clearly observed. In this section, it was observed that the NAF has an approximately vertical geometry. Three different stratigraphic units, namely Holocene aged alluvium and alluvial fan units, Pleistocene aged river terraces and Pliocene aged Örencik Formation could be defined in the section. Additionally, it is observed from the seismic reflection section that the NAF causes these stratigraphic units to have a negative flower structure. On the other hand, velocity gradient section of the seismic refraction tomography method shows that the undulating structures within the interfaces at shallower depths are in good agreement with the observed faults of the NAF zone at greater depths in the seismic reflection section.

Keywords: North Anatolian Fault; Adapazarı Basin; multi-channel seismic reflection
Investigation of a landslide: a case study from Eğridere, İzmir, Turkey

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Landslides are one of the catastrophic events, which cause damages to structures and lead to loss of life. Recently, a heavy rainfall triggered Eğridere landslide located at Bornova, Turkey. This mass movement damaged numerous houses at the site. The present study attempts to investigate the Eğridere landslide in means of geological and geophysical studies. Thus, the general characteristics of the landslide was defined in the study area. Geological map of the study area and surroundings was revealed, including boundaries of the landslide site. Geophysical studies were carried out in an area adjacent to the landslide and the slide potential was investigated. In addition, Electrical Resistivity Tomography and Seismic Surface Waves measurements were performed as geophysical methods to image the subsurface of the study area. Slope wash and andesite layers defined in geological investigations were followed in the geophysical results. Thus, the subsurface characteristics of the study area were examined. As a result, potential landslide prone area was determined according to the combination of geological and geophysical studies.

Keywords: ERT; Eğridere landslide; geology; MASW
Crosshole resistivity and seismic imaging: results of a synthetic study

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Nowadays, the importance of borehole geophysical method has been especially increased due to the insufficient surveys areas in surface investigations during the detailed modelling studies in urban sites. Crosshole application is the investigation of a region between two borehole with higher resolution and detailed than borehole measurements. The most commonly used methods are seismic, electrical resistivity, georadar and induced polarization.

In this study, a simulation of crosshole application of electrical resistivity and seismic refraction tomography methods are introduced. These popular methods apply mostly in a variety of engineering and environmental problems, which were used consequently to reveal their reliability for solving the complex subsurface problems. With this scope, we modeled some subsurface condition and compared the inverse-solution results of the two methods.

To evaluation the crosshole data sets of each technique MATLAB codes were developed. The reliability of these results was also evaluated by using the calculations of data and model root mean squares misfits. However, we revealed that the resolution of the ERT method is strongly dependent on the electrode configurations. Selection of the suitable electrode configurations is crucial to ensure a reliable inversion result. In the SRT application, we determined that the synthetic modelling results of the cube model were very reliable to define the models edges and velocities values. As a result, using ERT and SRT crosshole techniques together yields more reliable results to interpret such subsurface environments.

**Keywords**: crosshole; resistivity; seismic
Interpretation of Magnetic Data Using Radial Amplitude Spectrum Analysis: A Case from Gölcük/Isparta Region

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The Gölcük (Isparta) is in the southern side of city of Isparta in Mediterranean region of Turkey. This geothermal area is investigated with geophysical methods for determining its potential. The magnetic prospection is one of the most useful methods to determine buried geological structures such as formations including thermal water. This method is influenced by mostly ferromagnetic minerals, usually located along the contact zones in the geothermal areas. The investigation of total magnetic field variations over subterranean layers, which have been used for many years, may reveal their locations, geometries and physical characteristics. Magnetic studies were carried out at Gölcük Caldera at 78 measurement stations using a proton magnetometer. The data were mapped and Radial Amplitude Spectrum Method was used to obtain an average depth for the area.

Keywords: Isparta; Magnetic; radial amplitude spectrum
A Benchmark study: numerical fluid flow and temperature modeling of Basin and Range geothermal system

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Numerical fluid flow and temperature modeling studies are frequently used geothermal modeling studies. Number of computational fluid dynamics solvers are used and developed based on different numerical techniques such as finite element, finite difference and finite volume. The objective of this study is to show and prove the validity of the ANSYS FLUENT software on geothermal modeling studies. In order to do this, we selected the Basin and Range province which hosts a similar extensional tectonic structures as in Western Anatolia. Model geometry of the Basin and Range province consist of two mountain ranges which are approximately 1 km high, separated with a 9 km wide, 4km deep sedimentary basin. There is also a high permeability fault with high dipping angle (65°) present at the side of the sedimentary fill. This 23 km x 8 km cross-section discritized by 7471 uniform square elements. Fluid flow vectors and resulted temperature distribution are calculated. Numerical models predict smooth isotherms away from the fault zones where the fluid circulation does not significantly affect temperature gradient. On the other hand, there is a non-linear vertical geothermal gradient observed near the relatively high permeable zone (fault). Isotherms leaning towards the relatively high permeability zone (fault) indicate that the heat in the area transfered by convection cells.

Keywords: fluid flow modeling; temperature modeling; numerical models
Temperature and fluid flow modeling of gas bearing sediments in Offshore Antarctic Peninsula South Shetland Islands

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The purpose of the study is to construct a marine subsurface sedimentation model in order to simulate the heat and fluid flow dynamics of gas hydrate bearing sediments in Offshore Antarctic Peninsula, South Shetland Islands by using ANSYS Fluent software. The behavior and stability of the gas hydrates and hydrate related free gas (methane) are simulated through time by employing case-specific numerical modeling. Following the employment of numerical modeling, observing the chemical interaction of hydrate related free gas (methane) with groundwater and the change of mass fractions of the reactant of CH₄ (methane) and the products of CO₂ (carbon-dioxide) and H₂ (hydrogen) are the premising events to be observed through time. Another promising motivation to construct this study can be elaborated as detecting the prominent effects of the geological settlements, i.e. in-situ fault structures on the results of the problem. In order to detect these effects, a model which does not include in-situ fault structures in its system is constructed by applying the same rules. In this manner, the differences that the system of fault structures would make are uncovered. It is fundamental to state that throughout the sedimentation, porosity values and mass fraction of CH₄ are determined as 10 % and 90%, respectively. By considering that fact, a model with increased porosity and decreased mass fraction of CH₄ by up to 60 % and down to 40 %, respectively is also employed. In the light of the results, prominent effects of the in-situ fault structures are explicitly evident. In more detail, in the model with fault structures, the reactant of CH₄ is drained off very quickly while the products of CO₂ and H₂ are emitted directly through the faults. On the other hand, in the model without fault structures, CH₄ is consumed and dissipated throughout the sediment of chemical reaction, producing CO₂ and H₂ which also behave in the same manner, creating no dramatic events.

Keywords: Fluid flow modeling; temperature modeling; numerical models
Scientific Session C.4

GIS and Remote Sensing applications

Conveners:
Dr. Aykut AĞUN; Dr. Bekir Taner SAN;
Dr. Hakan Ahmet NEFESLİOĞLU
C.4. GIS and Remote Sensing applications
International Earth Science Colloquium on the Aegean Region, IESCA-2019, Izmir, Turkey
In fractured aquifers such as the tabular Liasic reservoir of Middle Atlas (northern Morocco), geological fracturing plays significant role in feeding patterns and governing water flows. The knowledge of the geometry of fractures and their connectivity is essential for a better characterization of the discontinuous reservoir and the assessment of water resources. The use of remote sensing techniques helped us to have the latest information, to easily cover a large surface and to quantify fracture networks.

We used VHR, VIRHR multispectral and GHR panchromatic Spot images. Several techniques like enhancement and sharpness optimization and different filtering have been applied in order to extract a new fracturing map, which was validated by a cross-analysis with various cartographic inventories of the study area and with a field survey. The statistical and 2D spatial analysis of the resulting data, based on the fractures azimuth and length, showed heterogeneous and high clustering fracturing which is predominated by NE-SW and NW-SE directions.

The application of the fractal geometry and power-law statistics has led to describe and to quantify the spatial distribution of fracture networks related to the scale and to determine the characteristic fracture lengths specific for the studied reservoir. The obtained results from the surface using imagery could be extrapolated, under some precautions, to the whole reservoir and to the deep aquifer beneath the Sais basin.

The used remote sensing techniques have been very useful for this case study in order to characterize and modeling this important aquifer and to contribute to protect water resources in the region.

**Keywords:** remote sensing; spot images; Middle Atlas aquifer; fracture networks; clustering; fractal
Indicator parameters such as alteration mineralogy, temperature and anomaly occurrences in elemental/mineral content are commonly used for the determination of mineral deposits. Determination of indicator parameters using remote sensing and satellite images provides important outcomes in terms of time, cost and accuracy of results. Havadan district is near Zamanti River and hosts various carbonate-hosted ore deposits such as Göynük, Denizovası, Körprüüstü, Tekkeocakları and Karnıyarık. Within the scope of this study, alteration and elemental anomaly zones were evaluated with multispectral image analysis methods from indicator parameters and specification of the remote sensing method which can be used in determination of ore deposits in the Havadan area was discussed. Major element geochemistry (XRF) and mineralogical studies (thin section and XRD) were applied on the samples which were taken from previously determined anomaly zones using image processing. GWR analysis showed that major oxides can be evaluated together. In conclusion, Havadan area shows high correlation between Pb, Zn, Fe-oxide and Mg-oxide, so remote sensing applications were based on iron oxide and dolomite mapping. Iron oxide anomalies which were obtained from Landsat, Sentinel and Aster satellite images provided a significant parameter in order to determine Pb-Zn depositions in the galleries. This study showed successful integration of classic geological methods and remote sensing applications.

**Keywords:** Lead-Zinc deposits; GIS; GWR; remote sensing; Kayseri; Havadan
A comparison for medium scale earthflow susceptibility maps obtained by physical data based methods, Besikduzu (Trabzon), NE Turkey

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In northeastern part of Black Sea Region, earthflow type of landslides is highly widespread due to the weathering conditions of rock units, steep topography and dense precipitation. Especially in the last years, due to the extreme precipitation and wrong land use applications, earthflow type of landslides has been frequently encountered in the region. As a consequence of these events, several injuries and dead also appeared. Considering all these issues, an effective hazard management has become indispensable. The first step of this necessity is to make a landslide susceptibility assessment. In this study, Besikduzu (Trabzon, NE Turkey) district was chosen as study area, and a landslide susceptibility assessment was carried out by physical data based methods.

For this purpose, two methods named SHALSTAB and SAFETYFACTOR, which are also included as a modeler tool in SAGA (QGIS) software, were used. SHALSTAB model computes grid cell critical shallow groundwater recharge values (CR in mm/day) as a measure for relative shallow slope stability, utilizing a simple model that combines a steady-state hydrologic model (a topographic wetness index) to predict groundwater pressures with an infinite slope stability model. SAFETYFACTOR model computes a slope stability (expressed as a factor-of-safety) raster according to the traditional infinite slope model theory.

Both these two methods need topographical and geo-mechanical data of the lithological units studied. Considering this necessity, a digital elevation model, that is a base data for the mentioned landslide susceptibility assessment was produced in a geographical information system (GIS) environment by 1:25,000 scale digital topographical sheets of the area. Then, geo-mechanical properties of soils samples such as cohesion, internal friction angle, and unit weight were determined by using undisturbed samples obtained from eleven locations in the study area. These geo-mechanical and topographical data were then used as input data for the two models, and the results obtained by processing of the data were compared with each other. At the end of the comparison of the model results, some differences were distinguished which were inferred as the differences of the model conceptions and algorithms. As results, both models were considered to be base data for a hazard assessment frame for the study area.

Keywords: earthflow, slope stability, GIS, soil
Use of close range photogrammetric methods for collecting detailed rock mass discontinuity data: an example from NE Turkey

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In slope stability problems for rock masses, collection of detailed discontinuity data is important and essential. To collect proper and detailed discontinuity data for rock slope faces is done by well-known methods such as compass measurements, direct expert observations etc. Today in the world, some specific and sophisticated methods to be photogrammetry and digital image processing approaches are also used. Among these methods, close range photogrammetry such as terrestrial LIDAR (light detection and ranging) is almost mostly used method. In this method, a 3D surface model (point clouds) from LIDAR images covering the slope surface is initially created. Then, the obtained points clouds are processed for obtaining a very detailed digital surface model. This surface model is then used to obtain discontinuity surfaces that are needed for an input data to slope stability assessment such as kinematical and limit equilibrium methods.

In this study, a highway road route, which is located at Maçka (Trabzon, NE Turkey) district, was considered as study area. This road route is used for reaching the Sumela Monastery that is holly for the Catholic Christian world, and annual vehicle traffic number is considerably high.

In point of engineering geology, this route suffers from rock fall and rock block slide cases. In this study, only data collection information for detailed rock mass slope discontinuity data was given that was carried out by terrestrial LIDAR measurement. In this context, eleven rock slope faces were surveyed, and the obtained data were then processed by DSE (Discontinuity Set Extractor) software. By this software, to extract discontinuity set data from the slope faces surveyed became possible. After processing of point cloud data in this software, discontinuity sets numbers that are defined by stereographic projection method environment were refined considering field observations, and these refined discontinuity sets were then prepared for kinematical slope stability analysis. The basic implication from all these findings is that the detailed information for discontinuity set, and orientations of the discontinuity surfaces can be obtained by terrestrial LIDAR measurement.

Keywords: rock mass; discontinuity; rockfall; photogrammetry; LIDAR