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Book of Abstracts
Contents

		Volume A: Papers 001–050	
A/A	**EC**	**AUTHORS and TITLE**	**PAGE**
1	93	Athanasios Agrafiotis, George Papathanassiou and Sotiris Valkaniotis **Monitoring the evolution of landslide phenomena using new technologies location: Pyrra Trikala**	**1**
2	268	Dimitra Amanatidou, Konstantinos Soukis, Christina Stouraiti and Klea Dimitri **Structural study of the Theodorion meta-migmatitic complex (Serbomacedonian massif, northern Greece)**	**3**
3	44	Vasilis Anagnostou, Pavlos Bonatis, Vasileios Karakostas, Christos Kourouklas, Eleftheria Papadimitriou, Angeliki Adamaki, Stefania Alexandra Andriopoulou Mounteanou, George Bathrellos, Stylianos Bitharis, Michalis Foumelis, Ion-Anastasios Karolos, George Kaviris, Elena Papageorgiou, Christos Pikridas, Vassilis Sakkas, Hariklia Skilodimou, Ioannis Spingos and Angelos Zymvragakis **Fostering FAIR approaches to the seismological data life cycle**	**6**
4	43	Vasilis Anagnostou, Eleftheria Papadimitriou, Vasileios Karakostas and Torbjörn Bäck **Detailing the stress pattern in the area of central Ionian Islands**	**12**
5	30	Stefania Alexandra Andriopoulou Mounteanou, George Bathrellos and Hariklia Skilodimou **Flood events over the past 115 years in the Municipality of Patras, southern Greece**	**17**
6	31	Stefania Alexandra Andriopoulou Mounteanou, George Bathrellos, Hariklia Skilodimou, Angeliki Adamaki, Vassilis Anagnostou, Stylianos Bitharis, Pavlos Bonatis, Michalis Foumelis, Vassilis Karakostas, Ion-Anastasios Karolos, George Kaviris, Christos Kourouklas, Eleftheria Papadimitriou, Elena Papageorgiou, Christos Pikridas, Vassilis Sakkas, Ioannis Spingos and Angelos Zymvragakis **HOMEROS project for natural hazards: An example from northern Peloponnese, Greece**	**23**
7	202	Emmanouil Antonakis and Nickolas Zouros **Digital Visualization of Geological Heritage at Lesvos UNESCO Global Geopark: The Role of 3D Animations in** Educational Experiences	**29**
8	82	Nikolaos Antoniadis and Constantinos Loupasakis **Land Subsidence and Flooding in the East Thessaly Plain: A Historical Overview**	**34**

9	205	Alkistis Antonopoulou, Nikolaos Depountis and Sotirios Kokkalas **Geological suitability in remote mountainous settlements using the AHP method. The case study of the settlement of Klepa in Greece**	**38**
10	16	George Apostolopoulos, Alireza Malehmir, Ioannis Vakalas, Haralambos Kranis, Konstantinos Leontarakis, Christos Orfanos, Emmanouil Konstantinidis, Magdalena Markovic, Myrto Papadopoulou, Stylianos Chailas, Emmanouil Skourtsos, Andreas Tzanis and Evaggelos Spyridonos **Legacy data analysis combined with an integrated geological and geophysical survey for geothermal site exploration at Petra-Lesvos, Greece**	**44**
11	256	Konstantina Apostolopoulou, Efthimios Karymbalis, Maria Salomidi and Evangelia G. Drakou **Modelling Coastal Protection as an ecosystem service in the Greek coastal zone**	**50**
12	305	Konstantina Maria Apostolou, Elissavet Feloni and Anastasia Stergiadou **Simulation of Domestic Rainwater Harvesting Systems on Fourni Island, Aegean Sea: Assessing Efficiency Under Historic and Climate Change Scenarios.**	**55**
13	28	Foteini Aravani, Lambrini Papadopoulou, Antonios Koroneos and Alexandros Chatzipetros **Metapelitic assemblages in the contact metamorphic zone of the Varnous plutonite (NW Macedonia, Greece): preliminary results.**	**63**
14	135	Ariadne Argyraki, Artemis Kontomichalou, Zacharenia Kypritidou and Alexandros Liakopoulos **Balancing Precision and Resources: The Effect of Sampling Density in Regional Soil Geochemical Mapping**	**69**
15	318	Stella Arnaouti and Olga-Joan Ktenidou **Seismic resilience of primary water transfer network at Lagadas municipality, North Greece**	**74**
16	23	Nikolaos Arvanitidis, Konstantinos Laskaridis and Christos Christidis **Implementing the Critical Raw Materials Act to explore strategic minerals potential in Greece**	**81**
17	173	Pavlos Asteriou, Dimitrios Sotiriadis, Eleni Petala, Labros Kazelis and Nikolaos Klimis **Assessing the effect of 2023 Evros Wildfire: a new Post-Fire Rockfall Hazard System**	**89**
18	331	Ioannis Athinelis, Eleftheria Basiou, Triantafyllos Falaras and Issaak Parcharidis **Estimation of the displacement components in South Aegean islands as a response to the early 2025 seismicity of the Anydros Islet using Sentinel-1 imagery.**	**96**

19	332	Ioannis Athinelis, Ignacio Castro Melgar, Theodoros Gatsios, Pavlos Krassakis and Issaak Parcharidis **Employing Sentinel-1 imagery to monitor the deformation rate over the caldera of the Santorini Volcanic Island Complex using multitemporal InSAR from January 2023 up to February 2025.**	**104**
20	321	Efstratios Avgerinos, Efthymia Kostopoulou, Ioannis Tegoulias and Christos Giannakopoulos **Impacts of Climate Change on Maritime Conditions and Medicane Formation: Analyzing SST Changes in the Eastern Mediterranean (1940–2023) using Thematic Maps**	**111**
21	128	Pavlos Avramidis, Alexis Ramfos, Ioannis Sarris, Dionisios Christodoulopoulos, Marinos Alexandridis, Maria Michalopoulou, Nikolaos Depountis and Stefanos Papazisimou **Seasonal Water Column Stratification and Heavy Metal Distribution in the Pinios Dam Reservoir: A Comprehensive Environmental Monitoring Study**	**117**
22	158	Antonios Isidoros Avrithis, Efterpi Koskeridou, Evangelia Rentoumi, Evangelos Vlachos and Davit Vasilyan **A Preliminary Review of Microvertebrate and Invertebrate Fauna from the Early Pleistocene of Koukos region (Kos Island, Dodecanese, Greece)**	**119**
23	125	Mohammad Mahdi Badami, Yashar Aghaei and Constantinos Sioutas **Impact of Emission Regulations on the Temporal Trends of Toxicity of PM2.5 in Los Angeles**	**123**
24	235	Athanasia Bakopoulou, Chrysi Dousiaki, Michalis Diakakis, Emmanouil Andreadakis, Spyridon Mavroulis, Maria-Evangelia Gogou, Haralambos Kranis, Assimina Antonarakou and Efthymios Lekkas **Teachers' experience, attitudes and skills on flood events: The case of Daniel storm 2023, Thessaly, Greece**	**127**
25	203	Eftychia-Christina Bardi, Paraskevi Lampropoulou, Alexandros Sergoulopoulos, Aikaterini Rogkala, Panagiota P. Giannakopoulou, Fotis Margaritis, Dimitrios Papoulis, Anastasios Tsinidis, Islam Ihtisham and Petros Petrounias **A (preliminary) comparative gemmological-mineralogical study of quartz crystals derived from Greece and Brazil**	**130**
26	77	Vasiliki Barsaki, Irene Michailidou, Filio Peppa, Georgia Kerdela and Eugenia Moraiti **The UNESCO Global Geopark of Lavreotiki: a pillar for climate change adaptation & the example of sustainable water use, Greece**	**136**
27	96	Vasiliki Barsaki, Panagiotis Voudouris and Eugenia Moraiti **The world class geodiversity of the Lavreotiki UNESCO Global Geopark's minerals, Lavreotiki Municipality, Greece**	**140**
28	261	Vasiliki Barsaki, Irene Zananiri and Eugenia Moraiti **Highlighting the Geological Heritage of the Island of Kythira, Greece**	**143**

29	151	Davide Bartolozzi, Sotiria Kothri, Maria Filomena Loreto, Nomikou, Ganas, Valentina Ferrante, Kei, Fabrizio Balsamo, Lampridou, Ranero and Nikoli **Mapping the geo-hazard elements offshore the Ionian Islands (Western Greece)**	**149**
30	362	Dimitrios-Vasileios Batzakis, Efthimios Karymbalis and Konstantinos Tsanakas **Assessing earthquake-triggered tsunami hazard in Santorini-Amorgos Tectonic Zone: A deterministic simulation-based approach**	**155**
31	161	Konstantina Bejelou, Paraskevi Nomikou, Solveig Bühring, Dimitrios Papanikolaou, Stephanos Kilias, Andrea Koschinsky-Fritsche, Wolfgang Bach, Karsten Haase, Christian Ferreira, Evgenia Bazhenova, Alissa Bach, Yukari Azakura, Danai Lampridou, Areti Belka, Eirini Anagnostou, Effrosyni Varotsou and Sotiria Kothri **Oceanographic survey M192 off Milos reveals tectonic controls on hydrothermal vent distribution in a complex volcanic-tectonic system of the South Aegean**	**162**
32	262	Alexandros Belesis, Ioannis Tsentzos, Maria Belesis and Ioannis Koukouvelas **Storm Daniel flooding of Larissa City: embankments failure the aftermath**	**166**
33	149	Areti Belka, Paraskevi Nomikou, Solveig Bühring, Konstantina Bejelou, Danai Lampridou, Alissa Bach, Sotiria Kothri, Effrosyni Varotsou and Dimitrios Papanikolaou **Morphotectonic analysis of Antimilos volcanic Group**	**173**
34	357	Konstantina Bentana and Nickolaos Zouros **Geoheritage as a tool to engage children with the Sustainable Development Goals in UNESCO Global Geoparks: Best practices in educational activities from Lesvos Island UNESCO Global Geopark**	**180**
35	55	Evangelia Besiou, George Kontakiotis, Iuliana Vasiliev and Assimina Antonarakou **Environmental controls on Globorotalia menardii size variability preceding the Tortonian/Messinian boundary**	**184**
36	61	Pavlos Bonatis, Vasileios Anagnostou, Vasileios Karakostas, Christos Kourouklas, Eleftheria Papadimitriou, Angeliki Adamaki, Stefania-Alexandra Andriopoulou-Mounteanou, George Bathrellos, Stylianos Bitharis, Michael Foumelis, Ion-Anastasios Karolos, George Kaviris, Elena Papageorgiou, Christos Pikridas, Vassilis Sakkas, Hariklia Skilodimou, Ioannis Spingos and Angelos Zymvragakis **Cultivating FAIR principles for multi-hazard assessment**	**188**
37	86	Vasileios Boumpoulis, Maria Michalopoulou, Anastasios Kazolias, Maria Geraga, Nikolaos Depountis and George Papatheodorou **Development of an index-based methodology for assessing coastal vulnerability at a national scale and preliminary results**	**193**
38	207	Evangelia Bouranta and Ioannis Hatzopoulos **Development of a Geographic Information System for the Near-Real-Time Management of the seismic risk. Case study: The city of Mytilene, Lesvos (Greece)**	**197**

39	59	Nicolina Bourli, Chrysanthos Botziolis, Penelope Papadopoulou, Panagiotis Zelilidis, Elena Zoumpouli, George Iliopoulos, Angelos G Maravelis, Efthymios Tripsanas, Ioannis Oikonomopoulos, Aristotelis Pagoulatos and Avraam Zelilidis **Facies and depositional architecture of Upper Miocene tidal flat sedimentation in Kefalonia and Corfu Islands, West Greece**	**203**
40	330	Simon Bufféral, Pierre Briole, Aurélien Dupont, Javier Escartin and Philippe Heinrich **Tsunami Modelling for a Potential Earthquake between Santorini and Amorgos (Greece)**	**204**
41	312	Riccardo Caputo, Iannis Koukouvelas, Giorgos Papathanassiou, Davide Russo, Maria Taftsoglou, Gabriele Tarabusi and Sotiris Valkaniotis **The Greek Database of Seismogenic Sources (GreDaSS) version 3.0. A compilation of potential seismogenic sources (Mw> 5.5) in the Aegean Region**	**211**
42	2	Ismar S. Carvalho, Maria Helena P. Henriques and Giuseppe Leonardi **Sousa Dinosaur Valley, Brazil: The largest record of Lower Cretaceous dinosaur footprints in South America and its influence in local communities**	**217**
43	279	Stylianos Chailas and Andreas Tzanis **A Preliminary 3D Gravity Model for the pre-Volcanic Basement of Lesvos Island, Greece**	**223**
44	296	Paraskevi Chantzi, Sofia Doani and Konstantinos Albanakis **Sediment dynamics in the Sperchios river basin and their influence on stevia cultivation**	**229**
45	299	Angelos Chasiotis, Elissavet Feloni and Panagiotis Nastos **Sustainable Practices for Resilient Hydrosystems at a Municipal Level: Insights from the Greek Island of Chios**	**232**
46	271	Theodora Chatzakou, Aikaterini Tsiri, Antonios Koroneos, Ioanna Gerontidou and Alexandros Drakoulis **Kentavros plutonite (Thrace, Greece): Geochemistry and Petrogenesis**	**237**
47	51	Efstratia Chatzi, Evangelia-Theodora Derdemezi and Georgios Tsilimigkas **The Impact of Urban Sprawl on Areas of Natural and Cultural Heritage and Geoheritage. Evidence of Lemnos island, Greece**	**243**
48	255	Emmanouil Chatziangelis, Vasileios Boumpoulis and Nikolaos Depountis **Slope failures of friable sandstone in coastal areas. A Case study from Western Greece.**	**248**
49	248	Nikolaos Panagiotis Chatzigogos, Agisilaos Poulios and Thomas Makedon **Settlements in residual soils**	**254**
50	253	Alexandros Chatzipetros and Vassiliki Samantzi **Geotopes of Thessaly (central Greece) and their educational approach**	**259**

Volume B: Papers 051–100

A/A	EC	AUTHORS and TITLE	PAGE
51	350	Dimitrios Chatzistratis, Isavela Monioudi, Theodoros Chalazas, Olympos Andreadis, Konstantinos Moschopoulos, Antonis Chatzipavlis, Fotis Psarros and Adonis Velegrakis **Flood risk of a touristic island beach under Climate Change: Komi beach Chios**	**265**
52	182	Themistoklis Chatzitheodosiou, Ioannis Farmakis, Dimitra Papouli, George Stoumpos, George Prountzopoulos and Vassilis Marinos **Three Years of Progress in Digital Applications and Monitoring Utilizing 3D Reality Capture Technologies for Landslide Hazard Mitigation, the Case in Evritania, Central Greece**	**269**
53	314	Eleftheria Christodoulopoulou, Olga Ktenidou and Grigorios Tsinidis **Mapping and Categorization of damage on the built and natural environment caused by the 2023 Daniel and Elias storms in Mount Pelion, Greece**	**274**
54	7	Demerios Constantinides **ERBE SYMPOSIUM 2027– LAVRION GREECE: Honouring the Values of Geo-Mining Heritage**	**278**
55	11	Salomé C. Custódio, Maria Helena Henriques and Artur A. Sá **The Geoheritage of the "Atlantic Geopark" Project (Central Portugal) at a Glance**	**284**
56	70	Panagiota Dalgkitsi, Alfred Uchman, Chrysanthos Botziolis, Panagiotis Zelilidis, Nicolina Bourli and Avraam Zelilidis **The transitional deposits from carbonates to clastic in the Pindos foreland basin: an example from the Mazia village, Ioannina region, Greece**	**290**
57	210	Maria Georgia Dasoula, Zafeiria Roumelioti, Efthimios Sokos and Sotirios Kokkalas **Statistics on seismic moment tensors for the Aegean Sea and surrounding area: preliminary results**	**291**
58	206	Stamatia Deligianni and Alexandros Chatzipetros **Environmental Seismic Intensity Scale (ESI 2007)**	**297**
59	223	Klea Dimitri, Christina Stouraiti, Dimitra Amanatidou and Konstantinos Soukis **The Triassic post-collisional high-K alkali-calcic granites in the Vertiskos Unit, Serbo-Macedonian Massif: insights from Miriofito granite, Kerkini complex, Greece**	**303**
60	146	Evangelia Dimou, Angeliki Papoutsa, Vasilios Pletsas, Nikolaos Zegkinoglou, Stephanos Kilias, Paraskevi Nomikou and Paraskevi Polymenakou **Biogenicity of Arsenic Sulfide Biomorphous Structures in Deep-Sea Hydrothermal Vents, Kolumbo Arc Volcano: Morphological, Mineralogical and Geochemical Evidence**	**307**
61	143	Vasiliki Grigoria Dimou, Olga Koukousioura, Gyorgy Less, Maria Triantaphyllou, Margarita Dimiza, Georgios Syrides and Martin Langer **Microfacies and species richness analyses of middle-late Eocene western Thrace Basin (Neotethys Ocean, Greece): Paleoenvironmental evolution and species-richness hotspot revealed**	**314**

62	242	Panagiotis Sotirios Dittopoulos and Alexandros Chatzipetros **Using alternative methods to promote geoheritage: the Koziakas Mt., central Greece, case study.**	**317**
63	54	Antonia Dretaki and Alexandros Chatzipetros **Assessment of fault hazard in the broader area of Sitia, Eastern Crete**	**323**
64	264	Antonia Dretaki, Panagiotis Sotirios Dittopoulos, Alexandros Chatzipetros, Vasilios Papavasiliou, Nikolaos Paspaliaris, Georgios Tsirakakis and Evangelos Perakis **Formation of Sitia's Geopark (Crete Island, Greece) caves in correlation with the structural setting of the area**	**329**
65	27	Hara Drinia and George Zafeiropoulos **Enhancing Geoheritage through GEOAM: A Case Study of Tinos Island, central Aegean Sea, Greece**	**336**
66	244	Hara Drinia and Georgios Zafeiropoulos **Tinos Island, Aegean Sea, Greece, Geopark: A Pioneering Initiative in Climate Change Resilience and Geoconservation**	**339**
67	13	Christos Drougas, Efstratios Kelepertzis, Zacharenia Kypritidou, Evangelia Sigala, Christos Roumpos, Georgios Louloudis, Eleni Mertiri and Evangelos Oikonomopoulos **Hydrogeochemical Characteristics of Alfeios River and the wider hydrographic Network in the Lignite Basin Area of Megalopolis**	**342**
68	71	Panagiotis Elias, Gaetano Festa, Lauro Chiaraluce, Pascal Bernard, George Kaviris, Christos Evangelidis, Efthimios Sokos, John Clinton, Alexandru Marmureanu, Simona Colombelli, Mariano Supino, Dimitris Paronis, Vassilis Karastathis, Men-Andrin Meier, Semih Ergintav, Alessandro Vuan, Tomas Fischer, Stanka Sebela, Dimitris Paliatsas, Anna Serpetsidaki and Andreas Karakonstantis **EU funding to integrate cutting-edge methodological and technological solutions, enabling the development of a next-generation network of Near Fault Observatories across Europe (project TRANSFORM^2)**	**348**
69	315	Martin Engi, Andreas Gialoglou, Panayiotis Koutsabasis, Valentin Laurent and Constantinos G. Mavrogonatos **The Syros GeoPark Project**	**351**
70	342	Christos Evangelidis and Ioannis Fountoulakis **The 2024–2025 Seismic Sequence in the Santorini-Amorgos Region: High-Resolution Seismological Insights into a Volcano-Tectonic Crisis**	**356**
71	250	Dionysia Fasoli and Elizabeth Stathopoulou **Tooth enamel meso- and microstructure of fossilized Hipparionine horses of Pikermi (Attica, Greece)**	**359**
72	208	Charalampos Fassoulas, Spyridon Staridas and Emmanouel Nikolakakis **Local driven protection of a tectonic geosite, in Crete, Greece: The Paligremnos Protected Landscape**	**363**

73	354	Charalampos Fassoulas, R. Tamborrino, P. Bolca, G. Marra, G. Mezzalama, V. Tackacs, N. Leonhardmair and M.E. Demir **Assessing the management of Arkalochori EQ crisis in Crete, Greece under the implementation of RESILIAGE project in order to strengthen community resilience**	**368**
74	136	Eugenia Fatourou, Aikaterini Kafetzidou, Fabienne Marret, Konstantinos Panagiotopoulos and Katerina Kouli **Quaternary eustatic cycles and their impact on the Paleoceanography of the Gulf of Corinth (NE Mediterranean Sea)**	**374**
75	227	Kyriaki Fellachidou and Georgios Lazaridis **Underground rivers in Greece**	**377**
76	292	Christos Filis, Emmanuel Skourtsos, Armela Korovesai, Emmanuel Andreadakis, Eleni Kapourani, Nikolaos Karalemas and Apostolos Alexopoulos **Preliminary estimation of the recession coefficient of the "Kefalari Agios Ioannis" spring, Dimitsana, Peloponnesus, Greece**	**381**
77	336	Michael Foumelis, Elena Papageorgiou, Elisa Trasatti, Deodato Tapete, Stylianos Bitharis, Christos Pikridas and Costas Papazachos **Role of Earth Observation in Monitoring Santorini–Anydros Volcano-Tectonic Crisis**	**386**
78	204	Kalliopi Elli Fragkouli, Georgios Drakatos, Spyridon Pavlides and Sotirios Sboras **Seismotectonic Features of the 2023 Strong Earthquake Sequence in Southeast Turkey.**	**389**
79	62	Dimitris Galanakis, Dimitris Sakellariou, Sotiris Sboras, Spyros Pavlides, Kyriaki Iordanidou, Charalambos Georgiou, Athanasios Ganas, Yiannis Koukouvelas, Charalampos Kranis, Spiros Lalexos, Theodora Rondoyanni and Efthymios Lekkas **The Hellenic DataBase of Active Faults (HeDBAF): a new national geodatabase**	**393**
80	120	Odysseus Galanis and Areti Panou **An investigation of the use of deep-neural-network-based seismic arrival time picking methods for the automatization of earthquake sequence monitoring: The case of the November 3, 2024 MW 5.3 Kassandra earthquake**	**397**
81	37	Erasmia Galazoudi, George Bathrellos, Hariklia Skilodimou, Ioannis Koukouvelas and Konstantinos Nikolakopoulos **Evolution of map-making from prehistoric times to the Middle Ages**	**403**
82	22	Athanassios Ganas, Dimitrios Anastasiou, Georgios Mavropoulos, Ioannis Karamitros, Konstantinos Nikolakopoulos and Varvara Tsironi **Ground motion monitoring with low-cost multi-GNSS installations in Achaia, western Greece**	**408**
83	343	Athanassios Ganas, Pierre Briole, Varvara Tsironi, Georgios Goutsos, Nicolaos Madonis, Eustratios Liadopoulos and Ioannis Mintourakis **Geodetic monitoring of the 2024–2025 Santorini volcanic unrest using GNSS and InSAR data: preliminary results**	**413**

84	21	Athanassios Ganas, Francesco Carnemolla, Ioannis Karamitros, Nikolaos Madonis and Vasileios Georgakopoulos **Geodetic monitoring of the Methana volcano (central Greece) using campaign GNSS data: preliminary results**	**417**
85	254	Athanassios Ganas, Vasilis Kapetanidis, Varvara Tsironi, Andreas Karakonstantis and Ioannis Karamitros **Integrated monitoring of the Milos geothermal site (Cyclades, Greece) using InSAR, GNSS and local seismic network data**	**422**
86	102	Athanassios Ganas, Varvara Tsironi, Georgios Goutsos, Eirini Efstathiou, Christina Tsimi, Nikolaos Madonis and Vasileios Georgakopoulos **NOAFAULTs: 12-yrs of studies and investigations towards building a geospatial database for active faults in Greece and surrounding areas**	**427**
87	307	Amalia Gasteratou and Effie Kostopoulou **Climatological analysis and Trend Assessment of Climate Indices in two forest areas of Greece experienced extreme fire events in 2023.**	**430**
88	33	Alexandra Gemitzi, Odysseas Kopsidas, Foteini Stefani, Apostolos Polymeros, Vasilis Bellos and George Falalakis **A flood hazard assessment tool using satellite based high resolution land cover dataset within Google Earth Engine**	**436**
89	358	Gonca Gençalioğlu Kuşcu and Göksu Uslular **How medial tephra records contribute to proximal tephrochronology: Case study of Nisyros Volcano**	**441**
90	169	Maria Georgaki, Hrissi Karapanagioti, Małgorzata Wojtaszek-Kalaitzidi and Stavros Kalaitzidis **Evaluation of PAHs sorption behavior in coals and cokes**	**444**
91	138	Maria Nefeli Georgaki, Athanasios Georgakis, Dimosthenis Sarigiannis and Nerantzis Kazakis **Groundwater Quality Evaluation of Thessaly and Peloponnese: Data Analysis of 2019 year and Evidence of Degradation**	**448**
92	309	Georgios P. Georgalas, Polychronis Kolokoussis, Sofia Laskari and Konstantinos Soukis **Automatic Detection and Extraction of Geological Lineaments on Amorgos Island Using Satellite Data and Open-Source Software**	**454**
93	87	Ioanna Gerontidou and Antonios Koroneos **Major and trace element analysis on geological samples using WD-XRF on pressed pellets**	**458**
94	142	Dina Ghikas and Anna Batsi **The Art of Stone in Grevena-Kozani UGGp: Community-led Conservation Efforts**	**465**

95	63	Christina Giamali, George Kontakiotis and Assimina Antonarakou **Paleoecological imprints of pteropod assemblages and their response to sapropel S1 conditions in the eastern Mediterranean Sea**	**468**
96	212	Panagiota P. Giannakopoulou, Aikaterini Rogkala, Paraskevi Lampropoulou, Petros Koutsovitis, Maria Kalpogiannaki, Vasileios Giamas, Odyseas Seikatis, Ihtisham Islam and Petros Petrounias **Correlation study of overland and marine aggregates capable to be used in various construction applications**	**472**
97	69	Anna Giannakou, Nikolaos Soulakellis, Nikolaos Zouros and Dimitrios Kavroudakis **Estimation of an empirical relationship for calculating quantities of demolished materials through three-dimensional visualization of buildings affected by the earthquake of June 12, 2017, in Vrisa, Lesvos.**	**477**
98	282	Katerina Giouri, Christos L. Stergiou, Vasilios Melfos, Lambrini Papadopoulou, Nikolaos Kantiranis, Irena Peytcheva and Elitsa Stefanova **Preliminary results on the toxic elemental accumulation in the Fe-oxides of the stream sediments from Palea Kavala, Northern Greece**	**482**
99	311	Salvatore Giuffrida, Letizia Anderlini, Shannon Graham, Francesco Carnemolla, Fabio Brighenti, Giorgio de Guidi, Flavio Cannavò and Riccardo Caputo **Investigating the interseismic coupling degree of the northern Apennines external Arc in Emilia Romagna region, (northern Italy).**	**488**
100	117	Antonela Gjika, Christina Stouraiti, Panagiotis Voudouris, Konstantinos Laskaridis, Marianthi Anastasatou, Constantinos Mavrogonatos and Harald Strauss **Geochemical and Mineralogical Study of the Antimony (Sb)-mineralization at the north Pelion region, Magnesia, Greece**	**491**

Volume C: Papers 100–150

A/A	EC	AUTHORS and TITLE	PAGE
101	355	Konstantinos Gkogkas, Costas Papazachos, Nikolaos Chatzis, Dominikos Vamvakaris, Eleni Karagianni, Chrisa Ventouzi, Alexandros Vellis, Nikolaos Anterriotis-Kalpakidis, Dimitrios Madelis, Parthena Paradisopoulou, Eleni Aidona and Christos Pikridas **SantoArray: Densifying station coverage in Santorini amidst the Amorgos-Anydros earthquake swarm crisis**	**494**
102	337	Marilia Gogou, Nafsika Ioanna Spyrou, Spyridon Mavroulis, Niki Evelpidou, Maria Mavrouli, Efthimis Lekkas and Assimina Antonarakou **Assessment of assembly point suitability in tsunami-prone South Aegean coasts after the 2025 Santorini-Amorgos earthquake swarm and related risk reduction measures**	**498**
103	165	Vasilis Golfinopoulos, David J. W. Piper, Avraam Zelilidis, Georgia Pe-Piper, Penelope Papadopoulou, Nicolina Bourli and George Iliopoulos **Palaeoenvironmental Interpretation and Soft Sediment Deformation of the Ionian Basin Lower Jurassic Formations in Astakos (Western Greece)**	**504**
104	234	Georgios Goutsos, Vasiliki Kouskouna, Georgios Sakkas and Nikolaos Sakellariou **A decade of data: Updating the Hellenic Macroseismic Database for historical earthquakes**	**508**
105	18	Ioannis Grendas and Zafeiria Roumelioti **Seeking for dependencies of the high frequency "kappa" parameter of earthquake spectrum on weather/climate conditions**	**514**
106	326	Georgios Grimpylakos **Digital model of Hydrological components, Mean annual Temperature, Precipitation and Evapotranspiration in Macedonia, Greece**	**521**
107	75	Maria Groumpou, Ioannis Koukouvelas, Konstantinos Nikolakopoulos, Josep Sanjuan, Penelope Papadopoulou and George Iliopoulos **The Pheneos palaeolake in N. Peloponnese, Greece**	**527**
108	131	Maria Grylionaki, Nikolaos Theodoulidis, Areti Panou and Panagiotis Chatzidimitriou **Estimation of soil vulnerability index in the metropolitan area of Thessaloniki (Greece)**	**530**
109	9	Levent Gülen **Seismotectonics of the NE Aegean region: The Lesvos Island and the Gulf of Edremit**	**531**
110	366	Erdal Gumus, Nikolas Zouros **The rocks connect us: Volcanic geoheritage of Lesvos Geopark (Greece) and Ida Madra Geopark (Türkiye)**	**537**
111	324	Petros Hadjicostas and Evi Kazamia **Assessing Climate Change Impacts on Troodos Mountain (Troodos UNESCO Global Geopark area) Through Methodological Approaches and Community Engagement in the ClimEmpower Project**	**542**

112	4	Maria Helena Henriques, Salomé C. Custódio and Ismar S. Carvalho **Geoconservation in Portugal: an overview**	**543**
113	247	Iatrou Alexandra, Karakostas Dimitrios, Fragkiskos Markozanes, Aikaterini Karditsa and Serafeim Poulos **Beach retreat due to sea level rise induced by climate Change: The case of the Korasida, Heromylos and Limnionas beaches of south Evia facing the Aegean Sea.**	**549**
114	294	George Iliopoulos, Penelope Papadopoulou, Ilias Valiakos and Nickolas Zouros **Contribution to the stratigraphic study of the pyroclastic Formations of the Lesvos Petrified Forest, Lesvos Island, Greece.**	**552**
115	209	Dimitrios Ioannidis, Emmanouil Katrivanos and Alexandros Chatzipetros **Geological study of the basement structure in the wider area of Filiro (Circum-Rhodope Belt, Central Macedonia, Greece)**	**558**
116	313	Despoina Ioannidou and Olga-Joan Ktenidou **Integrating Geotechnical Data and Site Response Analyses in the Municipality of Chalandri, Athens, Greece**	**564**
117	319	Angelos Kannelos Irakleidis and Olga Joan Ktenidou **Seismic vulnerability of cultural heritage. The case of the archaeological museum of Rhodes: building performance, safety of the public and exhibits**	**570**
118	157	Alexandros Wilfred Irakliotis and George Papathanassiou **Rock slope stability analysis on the road axis of Kleisoura – Kastoria, Greece**	**576**
119	140	Aikaterini Kafetzidou, Eugenia Fatourou, Konstantinos Panagiotopoulos, Fabienne Marret, Olga Koukousioura and Katerina Kouli **Relict Taxa and Refugial Dynamics in the Corinth Gulf: Insights from the Pollen Record**	**579**
120	94	Aikaterini Kafetzidou, Olga Koukousioura, Vassilis Zotiadis and Katerina Kouli **Rare Insights in the Oligocene flora of Thrace (Greece): Preliminary results from the Rhodopi Petrified Forest**	**581**
121	1	Maria Kaimakami **Mapping the geological landscape of NW bay of Navarino through time**	**583**
122	50	Maria Kakavas, Aggeliki Kyriou, Konstantinos Nikolakopoulos and Ioannis Koukouvelas **The influence of DSMs spatial resolution on rockfall simulation.**	**587**
123	8	Christina Kalaitzi and Dimitris Kostopoulos **The late Ruscinian leporid Trischizolagus (Leporidae, Lagomorpha) from Megalo Emvolon (Thessaloniki, Greece)**	**594**
124	171	Panagiotis Kalaitzis, Michael Foumelis, Antonios Mouratidis and Nikolaos Soulakellis **Multiscale Geo-visualization Dashboard of Persistent Scatterer Interferometry SAR Data, Lesvos Island, Greece**	**596**

125	221	Iraklis Kalogeropoulos, Georgios Lazaridis and A. Tsekoura **Methodology of cave mapping: comparison of surveys**	**601**
126	174	Kalpogiannaki Maria, Aikaterini Rogkala, Panagiota P. Giannakopoulou, Petros Koutsovitis, Paraskevi Lampropoulou, Petros Petrounias, Dimitrios Papoulis, Nikolaos C. Koukouzas and Panagiotis Pomonis **Geoeducational and Geotourism values of geological resources as novel path for Geosciences Education**	**605**
127	111	Isidoros Kampolis, Panagiotis Voudouris and Evgenia Moraiti **The pseudokarst at the Kaki Thalassa Bay reveals unknown ancient mining activities (Lavreotiki UNESCO Global Geopark)**	**610**
128	258	Christos Kanellopoulos, Vasiliki Aggelatou and Christos Papatrechas **Preliminary results of black sands in Corfu Island (Ionian Sea, Greece).**	**614**
129	220	Christos Kanellopoulos, Dimitrios Galanakis, Leonidas Moforis, Sotiris Sboras, Olga Chalkiadaki, Nikolaos Xirokostas and George Vougioukalakis **Preliminary results on Agios Efstratios island (NE Aegean Sea, Greece) geology.**	**617**
130	214	Christos Kanellopoulos, Dimitrios Galanakis, Sotiris Sboras, Kyriaki Iordanidou, Leonidas Moforis, Nikolaos Xirokostas, Olga Chalkiadaki and George Vougioukalakis **Pagasitikos volcanism (Lichades-Kamena Vourla-Achillio-Mikrothives-Porfyrio-Psathoura): Preliminary results on a Quaternary tectonically related volcanism.**	**620**
131	35	Konstantina Kantareli and Vassilis Sakkas **Investigating crustal deformation of Zakynthos Island using Satellite Interferometry (InSAR): pre- and post- seismic analysis of the October 25, 2018 earthquake**	**623**
132	80	Vasilis Kapetanidis, Ioannis Spingos, Christofer Kaltsas and George Kaviris **Application of a machine-learning model for the determination of focal mechanisms in the area of the Corinth Rift Laboratory Near-Fault Observatory (CRL NFO), Central Greece**	**629**
133	58	Athanasia Theodora Karachaliou, Dimitrios Vogiatzis and Nikolaos Kantiranis **Preliminary results of physicomechanical properties of lightweight mortars using palygorskite as sand replacement**	**636**
134	172	Özlem Karagöz and Onur Tan **Microtremor array explorations and the importance of local site effect in Western Türkiye**	**642**
135	335	Vasileios Karakostas, Anthony Lomax, Vasilis Anagnostou, Eleftheria Papadimitriou, Valerio Acocella, Stephen Hicks and Pierre Henry **The 2025 seismicity burst in the Santorini – Amorgos seismovolcanic zone**	**646**
136	367	P. Karanis **Climate changes, neglected and emerging diseases**	**651**

137	167	Efstratios Karantanellis, Vassilios Marinos and Anika Braun **AI-Driven Approaches for Landslide Modeling: Challenges and Opportunities**	**653**
138	226	Georgia Karountzou, Maria-Roi Panagiotaki, Dionisis Semitekolos and Costas Charitidis **Evaluation of Greek clay for pottery applications**	**656**
139	361	Jens Karstens, Paraskevi Nomikou, Marius Isken, Michelle Maree Parks, Vincent Drouin, Emilie E.E. Hooft, Thomas R. Walter, Mahmud Haghshenas Haghighi and Dimitris Anastasiou **The 2025 seismic crisis reveals a coupled magma feeding system at Santorini and Kolumbo**	**657**
140	280	Theodora Karympali **The role of painting as a historical indicator of relative sea-level change: a review**	**659**
141	154	Marianthi Katheri, Olga Koumoutsakou and Assimina Antonarakou **Challenges and Opportunities in the AI Era: Promoting Earth Science Education for Deaf and Hard of Hearing Students**	**666**
142	347	Ioannis Katsafados, Dimitrios Anastasiou, Melissinos Paraskevas, Maria Tsakiri, Paraskevi Nomikou and Costas Synolakis **Preliminary results of displacements from the recent seismic and volcanic crisis in the Santorini Island complex, Greece**	**668**
143	90	Anna Katsigera, Paraskevi Nomikou, Paraskevi Polymenakou, Sergio Sciré Scappuzzo, Gianluca Lazzaro, Aggelos Mallios, Valsamis Ntouskos, Sotiris Spanos, Christos Antoniou, Andrea Luca Rizzo, Manfredi Longo, Javier Escartin, Konstantinos Karantzalos, Walter D Alessandro, Lars-Eric Heimburger, Stephanos Kilias, Theodoros Mertzimekis, Fausto Grassa, Danai Lampridou, Eirini Anagnostou and Vasiliki Papadimitriou **SANTORY shallow seafloor observatory: First time series data from an active submarine volcano**	**674**
144	176	Chrysoula Katsora, Evaggelos Levadiotis, Ourania Tzoraki and Nektaria Papadopoulou **Flash drought assessment: insights from Lesvos island, Greece**	**677**
145	251	Katerina Kavoura, Garyfalia Konstantopoulou and Panagiotis Paschos **Rainfall-induced landslides in Corfu island: effectiveness of the regional scale landslide susceptibility map**	**681**
146	201	Nerantzis Kazakis, Ioanna Sideri, Maria Margarita Ntona, Vasiliki Stavropoulou, Dimitra Lampropoulou, Eleni Zagana and Konstantinos Voudouris **Origin of nitrate pollution in groundwater of Mygdonia Plain, Greece**	**685**
147	104	Shoaib Ahmed Khan, Theodora Tsourou, Emmanuel Skourtsos, Konstantinos Soukis, Ioannis Michailidis, Elisavet Skampa and Maria Triantaphyllou **Micropaleontological and paleoenvironmental study of carbonate intercalations within Boeotia (Greece) clastic formations**	**691**

148	79	Georgia Kitsaki, Christos L. Stergiou and Haritakis Papaioannou **"Vikos-Aoos Geopark: Toponyms as a Link Between Geological Heritage and Culture"**	**693**
149	241	Charalampos Kkallas, Costas Papazachos and Basil Margaris **A Duration Model for Strong Seismic Motions of Intermediate-Depth Earthquakes in the Southern Aegean and its implication for stochastic simulations**	**695**
150	49	Foivos Klimis, Olga Sykioti, Efthimios Karymbalis and Isaak Parcharidis **Lunar Pits: Statistical Analysis of Morphometric and Geophysical Properties**	**700**
151	92	Aliki Kokkala, Vassilis Marinos and George Papathanassiou **Utilizing engineering geological database for urban geohazard assessment: a case study from Thessaloniki, Greece**	**706**
152	276	Sotirios Kokkalas, Vasileios Psarros and Petros Koutsovitis **Diapiric structures in evaporites of Western Greece as potential geoenergy storage areas.**	**709**

Volume D: Papers 151–200

A/A	EC	AUTHORS and TITLE	PAGE
153	281	Eleni Kolaiti, Nikolaos Soulakellis, Georgios Tataris and Nikos Mourtzas **The Argo-Beachrock Project: web mapping and geovisualisation of beachrocks using UAS along the coast of the Argolic Gulf, Greece**	**715**
154	353	Eleni Kolaiti, Nikolaos Zouros and Nikos Mourtzas **The Corinth Canal (Greece): monumentality and protection**	**721**
155	179	Maria Kolendrianou, Zacharenia Kefalogianni, Agapi Kalomoiri and Charalampos Fassoulas **Synergies for geo- education: materials and initiatives from Psiloritis UNESCO Global Geopark and the Center for Environmental Education and Sustainability of Anogia, (Crete) Greece.**	**728**
156	156	Pavlina Kolyva, Olga Koumoutsakou and Assimina Antonarakou **The Role of Fairy Tales in Fostering Geoscience Understanding in Early Childhood**	**735**
157	119	Georgios Kontokostas and Assimina Antonarakou **Application of the educational proposal for Geoscience: Geology in secondary education through educational geopaths in the urban environment.**	**737**
158	260	Orestis Kontopidis, Alexandros Theocharis, Nikolaos Koukouzas, Jan Burda and Ioannis Zevgolis **Interpretation of CPTu data for mining slope stability assessment in reclamation projects: The case of pit Lake Most, Czech Republic**	**740**
159	259	Orestis Kontopidis, Alexandros Theocharis and Ioannis Zevgolis **A semi-quantitative multi-hazard approach for Tailings Storage Facilities**	**745**
160	124	Efterpi Koskeridou, Christos Psarras, Evangelia Rentoumi, Ioannis Giaourtsakis and Marija Bošnjak **The role of the museums in the geoscience education– examples from the Museum of Paleontology and Geology of the National and Kapodistrian University of Athens, Greece and the Croatian Natural History Museum, Croatia**	**750**
161	17	Panagiotis Kosmas, Constantinos Loupasakis, Vasiliki Eleftheriou, Rozalia Christodoulopoulou and Antigoni Vrouva **Ultrasonic analysis of the structural stones of the Parthenon at the Acropolis of Athens – Investigation of the physical / mechanical properties and integrity control of the grouted Joints**	**753**
162	180	Georgia Kostaki, Hans-Juergen Gawlick, Adamantios Kilias, Sigrid Missoni, George Ghon and Emmanouil Katrivanos **The Koziakas Mélange Unit: New perspectives on Its Mesozoic paleogeographic and geotectonic evolution (Central Greece)**	**757**

163	308	Effie Kostopoulou, Christos Giannakopoulos, Constantinos Nefros and Constantinos Loupasakis **Assessing Climate Extremes as Drivers of Geohazards in Greece**	**763**
164	122	Sotiria Kothri, Paraskevi Nomikou, Maria Filomena Loreto, César Rodríguez Ranero, Danai Lampridou, Elisavet Nikoli, Irene Merino, Valentina Ferrante, Serafeim Poulos and Athanassios Ganas **Submarine geomorphological structures in the Ionian Sea, Greece**	**769**
165	66	Christina Kotsakostoudi, Anna Bourliva, Christina Mytiglaki, Lambrini Papadopoulou and Nikolaos Kantiranis **Heavy metal concentrations in indoor house dusts from the city of Thessaloniki, N. Greece: a small-scale study**	**773**
166	103	Artemis Kotsomitopoulou, Nikolaos Tsaparas and Galazoudi Erasmia **New Clypeaster fossils from South Crete (Rodakino, Rethymno)**	**778**
167	310	Athanasios Koukoulis and Markos Xenakis **Measurements of soil gas emissions (Radon and Thoron) in the municipality of west Lesbos, Stypsis – Petras, and correlation with tectonic structures (Rift Zone) of the subsidence coast of Petra**	**782**
168	152	Olga Koukousioura, Paraskevi Nomikou, Adam Woodhouse, Shun Chiyonobu, Paraskevi Polymenakou, Tim Druitt, Steffen Kutterolf, Thomas Ronge, Sarah Beethe, Alexis Bernard, Carole Berthod, Hehe Chen, Acacia Clark, Susan DeBari, Sofia Della Sala, Tatiana Fernandez-Perez, Ralf Gertisser, Christian Hübscher, Raymond Johnston, Christopher Jones, Kumar Batuk Joshi, Anna Katsigera, Stephanos Kilias, Gunther Kletetschka, Xiaohui Li, Michael Manga, Molly McCanta, Iona McIntosh, Abigail Metcalfe, Antony Morris, Katharina Pank, Vasiliki Papadimitriou, Ally Peccia, Jonas Preine, Masako Tominaga, Yuzuru Yamamoto, Takeru Yoshimoto and Dimitrios Papanikolaou **Foraminiferal response to a giant shallow-marine pyroclastic-flow-eruption from ancestral Santorini discovered by IODP Expedition 398 – Objectives, challenges and results of deep drilling into Christiana-Santorini-Kolumbo volcanic field**	**789**
169	139	Olga Koukousioura, Konstantinos Panagiotopoulos, Eugenia Fatourou, Aikaterini Kafetzidou, Paula Diz, Katerina Kouli and Patrick Grunert **Late Quaternary dynamics of paleoenvironments and ecosystems in the Gulf of Corinth (eastern Mediterranean): IODP Expedition 381**	**792**
170	100	Nikolaos Koukouzas, Pavlos Tyrologou, Christos L. Stergiou, Julio Carneiro, Paula Fernández-Canteli, Christina Karatrantou and Stamatina Asimakopoulou **Characterization of Sandstone Formations in the Mesohellenic Trough for CO2 Storage: Insights from the Integration of Optical Mineralogy, Geochemistry, and Automated Imaging Techniques**	**794**
171	153	Olga Koumoutsakou and Assimina Antonarakou **Unveiling the Potential of AI in Geoscience Education: A Student-Centered Perspective**	**800**

172	245	Vasiliki Koumpou, Serafeim Poulos, Aikaterini Karditsa, Stylianos Petrakis and Vasileios Kapsimalis **An insight to grain size composition of the beach sediment along the north coast of the Messiniakos Gulf (Greek Mainland).**	**803**
173	105	Alexandros Aristotelis Koupatsiaris and Hara Drinia **A systematic review of grey literature in Greek universities repositories to uncover Greek UNESCO Global Geoparks**	**805**
174	98	Alexandros Aristotelis Koupatsiaris and Hara Drinia **Assessing Educators' Sense of Place and Geoethical Awareness at the 4th Summer School of Sitia UNESCO Global Geopark**	**810**
175	41	Christos Kourouklas, Pavlos Bonatis, Eleftheria Papadimitriou and Vasileios Karakostas **Fault-based recurrence models and occurrence probabilities of large earthquakes (M≥6.0) in the Corinth Rift, Greece**	**817**
176	191	Petros Koutsovitis, Gerasimina Pahaki, Vasileios Giamas and Lemonia Kalantzi **A preliminary petrographic approach to the pyroclastic tuffs in the island of Tilos**	**824**
177	187	Petros Koutsovitis and Aikaterini Papaioannou **A preliminary petrographic approach of the altered Triassic volcanic lavas in Argolis, Greece**	**828**
178	183	Petros Koutsovitis, Konstantinos Tetisis and Georgia Kolovadi **Petrographic evidence for the metamorphic conditions in ultramafic rocks at Makrymalli – Evia Island**	**830**
179	36	Petros Koutsovitis, Michiel van der Meulen, Tirza van Daalen, Pavlos Tyrologou, Nikolaos Koukouzas, Alkiviadis Sideridis, Christos Karkalis, Michel Grégoire, Petros Petrounias, Theodoros Ntaflos and Konstantinos Lentas **An outline on some of the recently reported granitoids from St. Martin Island**	**831**
180	64	Evlampia Kouzeli, Olga Sykioti, Konstantinos Nikolakopoulos, Saeid Asadzadeh, Friederike Koerting and Daniel Schläpfer **Mineral mapping using satellite multispectral and hyperspectral data for a pyrite mine in the frame of the m4mining project**	**833**
181	298	Kalliopi Kravari and Dimitrios Emmanouloudis **A Novel Approach to Flood and Drought Management in Arid Regions using Multi-Agent Systems**	**840**
182	218	Phaedra Kravvariti, Andreas Tzanis, Vasileios Sakkas and Haralambos Kranis **Contemporary distributed block deformation in the South Aegean Sea (Greece), deduced by the analysis of continuous GNSS measurements**	**846**
183	291	Konstantina Krotka, Fikos Ilias and Papathanassiou George **Geophysical investigation of landslide phenomena in the Perivoli area, Grevena, using the electrical resistivity tomography method**	**852**

184	325	Olga-Joan Ktenidou, Antonia Papageorgiou, Fevronia Gkika, Erion-Vasilis Pikoulis, Kalliopi Fragouli, Fanis Chalaris, Spyros Liakopoulos, Ziya Cekinmez, Panagiotis Savvaidis and Christos Evangelidis **A holistic proposition for assessing reference station conditions**	**858**
185	6	Erwin Kunz **The Xerias Window near Argos (Peloponnesus)**	**863**
186	290	Anastasios Kyriakos, Grigorios Aarne Sakellaris, Vasilios Melfos, Christos L Stergiou, Lambrini Papadopoulou and Nikolaos Kantiranis **Mineralogy and Geochemistry of the Non-Sulfide Zinc-Lead Deposits, Thasos Island, North Aegean, Greece**	**864**
187	175	Anastasios Ladas, Vasileios Melfos, Lamprini Papadopoulou and Nikolaos Kantiranis **Study of the geochemical distribution of uranium and thorium in the soils of the Sarigiol Basin, Kozani, and their environmental significance.**	**870**
188	285	Lida Lakidi, Nafsika Ioanna Spyrou, Michalis Diakakis, Christos Filis, Evelina Kotsi, Spyridon Mavroulis, Emmanuel Skourtsos, Haralambos Kranis and Efthymios Lekkas **Flood Dredge Spoils Mapping with the Use of UAS and GIS: The Case of 2020 Evia Flood**	**876**
189	322	Aggelos Lamprakopoulos and Nikolaos Zouros **Contribution to the neotectonic study of West Lesvos**	**882**
190	213	Georgios Lazaridis, Bogdan Onac, Jo De Waele, Konstantinos Vouvalidis, Spyridon Gkelis, Vasilis Gerovasileiou, Konstantinos Trimmis, Kimon Papadimitriou, Panagiotis Georgiakakis, Kaloust Paragamian, Despina Dora, Savvas Paragkamian, Markos Digenis, Foteini Sdraka, C. Alexandropoulou, T. Alikakou, C. Arvaniti, N. Chatzinikolaou, K. Chavanidis, X. Georgopoulou, A. Giannopoulou, D. Koumparelou, C. Lytra and I. Simoglou **Field-Work Methods in Speleology: A Multidisciplinary Training Approach**	**888**
191	219	Georgios Lazaridis, Foteini Sdraka, M. E. Georgiadou, A. Batsi, D. Gkikas, Despina Dora and Konstantinos Trimmis **Evaluation of karst geosites in Grevena-Kozani UNESCO Global Geopark**	**892**
192	217	Georgios Lazaridis, Christos L. Stergiou, Alexandros Chatzipetros, Konstantinos Stamoulis, Despina Dora, Xenia Georgopoulou, Konstantinos Vouvalidis, Evangelos Nikolaou, Panagiotis Paschos, Georgia Kitsaki and Haritakis Papaioannou **Utilizing Information and Communication Technology for geosite development: The case of sulfuric acid caves in the Vikos-Aoos UNESCO Global Geopark**	**898**
193	148	Vasiliki Lianou and Petros Tsakiridis **Management of solid wastes from offshore oil drilling, based on their geochemical properties: A case study from the Prinos facilities in the Northern Aegean Sea.**	**903**
194	215	Eleni M. Liapi, George Iliopoulos and Nikolaos Zouros **Palaeobotanical study of the Vrisaki flora from the Lesvos Petrified Forest**	**906**

195	364	Marco Liuzzo, Cinzia Federico, Fausto Grassa, Christos Kanellopoulos, Kostas Kyriakopoulos, Spyros Lalechos, Maria Manousaki, Barbara Nisi, Giancarlo Tamburello, Franco Tassi, Orlando Vaselli, George Vougioukalakis, Antonio Paonita, Francesca Bianco and Walter D'Alessandro **Preliminary results of the fluid geochemistry surveillance campaigns on Santorini island (Greece) after the 2025 Anydros seismic sequence**	**912**
196	25	Athanasios Lois, Dimitrios Giannopoulos and Efthimios Sokos **Automated Seismic signals' identification: A statistical criterion for decreasing the false alarm rate; Implementation on synthetic data.**	**913**
197	123	Maria Filomena Loreto, Valentina Ferrante, Marco Ligi, Filippo Muccini, Camilla Palmiotto, Lorenzo Petracchini, Stefania Romano, Athanassios Ganas, Andrea Argnani, Alessia Conti, Marco Cuffaro, Alenssandra Pensa, Sotiria Kothri, Danai Lampridou, Irene Merino, Cesar R. Ranero and Paraskevi Nomikou **Mapping the active Faults affecting Ionians Islands, Western Hellenic Arc**	**917**
198	101	Georgios Lyras, Athanassios Athanassiou, Alexandra van der Geer, George Kontakiotis, Evangelia Besiou and Assimina Antonarakou **The Early Pleistocene vertebrate fauna of Vatera, Lesbos, Greece**	**922**
199	317	Parina Machaira, Effie Kostopoulou, Christos Giannakopoulos, Myrto Gratsea and Gianna Kitsara **Assessing the impact of climate change on olive cultivation in the Peloponnese, Greece: A long-term analysis using climate indices**	**925**
200	144	Efthymios Magkoufis, Athanassios Ganas, Konstantinos Nikolakopoulos and Betty Charalampopoulou **A WebGIS platform for the multiparametric monitoring of ground deformation and critical infrastructures under the name PROION**	**931**
201	246	Mangifesta M., Scalella G., Sciarra N. **An example of DsGSDs in Abruzzo Region (Central Italy): the complex case of Civitella del Tronto**	**935**
202	38	Emmanouil Manoutsoglou **The 'treasure' of aeolianites on the coastal front of Marathopoli Dialiskari, Messinia, Western Coast of the Peloponnese: rhizoliths petrified forest and historical abandoned quarries**	**939**
203	47	Emmanouil Manoutsoglou, Nikolaos Andronikidis, Ilias Lazos, Georgios Kritikakis, Nikolaos Economou, Emmanouil Steiakakis, Georgios Xiroudakis and Antonios Vafeidis **Monitoring sea water intrusion at Samaria Gorge National Park**	**945**

Volume E: Papers 201–250

A/A	EC	AUTHORS and TITLE	PAGE
204	26	Kyriaki Manta, Grigoris Rousakis, Maria Geraga, George Papatheodorou, Dimitris Sakellariou and Aristomenis Karageorgis **Preliminary results on sedimentological characteristics of Mass Transport Deposits (MTDs) during the Amorgos tsunami 1956: sediment provenance and geochemical elements.**	**949**
205	341	Spyridon Mavroulis, Andromachi Sarantopoulou, Maria Mavrouli, Assimina Antonarakou and Efthymios Lekkas **Increased preparedness in anticipation of an imminent disaster: actions during the early 2025 Santorini – Amorgos (Aegean Sea, Greece) earthquake crisis and lessons learned**	**955**
206	277	Vasileios Mazarakis, Konstantinos Tsanakas, Noam Greenbaum, Dimitrios Vasileios Batzakis, Alessia Sorrentino, Ioannis Tsodoulos, Kanella Valkanou and Efthimios Karymbalis **Application of GIS-Based Multicriteria Decision Analysis and Analytic Hierarchy Process for Flood-Hazard Mapping in the Messapios River Basin, Central Evia Island, Greece**	**962**
207	287	Margarita Melfou, Panagiotis Voudouris, Reiner Klemd, Manuel Keith, Alexandre Tarantola, Vasilios Melfos, Lambrini Papadopoulou and Nikolaos Kantiranis **Indium and tellurium enrichment in sulfides and sulfosalts at the Pefka high- to intermediate-sulfidation epithermal deposit, Rhodope, Greece**	**969**
208	84	Ioannis Michalakis, Adonis Photiades and Spyros Staridas **An Overview of Geological Map Sheets of Crete by HSGME**	**975**
209	20	Ioannis Michalakis and Eleni Tsolaki **Water Wells in Crete: Distribution by Municipality, Use, and Ownership—Results of a Systematic Inventory in Greece**	**981**
210	12	Ioannis Michalakis, Eleni Tsolaki, Constantinos Loupasakis, Konstantinos Voudouris and Charalampos Kontoes **Preliminary Results on Land Subsidence Induced by Groundwater Overexploitation Using Copernicus Sentinel Data: Insights from the Messara Basin, Crete**	**987**
211	118	Maria Michalopoulou, Nikolaos Depountis, Eleni Zagana and Pavlos Avramidis **Application of geochemical indices for heavy metal evaluation in the Pinios Dam, Greece**	**993**
212	127	Sofia Michalopoulou, Sara Faulwetter, Dionisios Christodoulopoulos, Alexis Ramfos and Pavlos Avramidis **The impact of aquaculture units on Copper (Cu) concentrations in marine sediments**	**999**
213	196	Georgios Michas **Spatiotemporal diffusion variability in seismic swarms**	**1004**
214	137	Zoe Misiri, Spyridon Lainas and Nikolaos Depountis **Hellenic Landslide Platform (He.L.P.): A Geospatial Landslide Inventory for Western Greece**	**1009**

215	78	Leonidas Moforis, George Kontakiotis, Assimina Antonarakou, Alexandra Zambetakis-Lekkas, Ahmad Sajjad, Panagiotis Paschos, Dimitrios Galanakis, Christos Kanellopoulos, Sotiris Sboras, Hammad Tariq Janjuhah, Ilias Lazos and Vasileios Karakitsios **Biostratigraphy, Sedimentary Microfacies, and Depositional Environment of the Paleocene-Early Eocene Calciturbidites in Gardiki Section (Epirus, Western Greece)**	**1014**
216	349	Isavela Monioudi, Dimitrios Chatzistratis, Adonis Velegrakis, Anastasios Risgos, Antonis Chatzipavlis, Antigoni Nikolaou and Olympos Andreadis **The geospatial characteristics of an island beach: the case of Kos, Greece**	**1018**
217	29	Eugenia Moraiti, Panagiotis Voudouris and Vassiliki Barsaki **Innovative educational programs at the Lavreotiki UNESCO Global Geopark: the ERASMUS+ "ARTeMIS" Program Action for Research and Teaching Mineral exploration Inclusive School, Greece**	**1023**
218	53	Hara Moshou and Hara Drinia **Empowering Future Generations: Incorporating Geo – Environmental Education on Climate Change into Greek Compulsory Education**	**1025**
219	19	Nikos Mourtzas, Antonis Gkiolas, George Papacharalambous, Anastassios Tsakonas and Eleni Kolaiti **Slope stability rehabilitation in the traditional settlement of Chora, Andros Island, Greece**	**1030**
220	32	Harry Moustakas, Zafeiria Roumelioti, Efthimios Sokos and Christos Evangelidis **The Horizontal-to-Vertical Spectral Ratio Method for Underground Voids Detection: Testing Over Mycenaean Tombs**	**1036**
221	194	Lemonia Moysidou, Ermioni Eirini Papadopoulou, Stavros Proestakis, Nikolaos Zouros and Nikolaos Soulakellis **Multiscale 3D mapping and Geovisualization of a Petrified Forest Park in Lesvos, Greece, using UAV.**	**1042**
222	301	Ch. Mpakopoulou, D. Tsesmelis, K. Kalogeropoulos, K. Vasilakou, E. Feloni, E. Zervas and A. Tsatsaris **Investigating Drought Dynamics in Greece Using Climate and Meteorological Indicators**	**1048**
223	40	Jan Mrlina **Density modeling based on gravity survey at faulted area around Aigion, Gulf of Corinth, Greece**	**1054**
224	39	Jan Mrlina **Gravity monitoring at Santorini volcanic island, Greece**	**1060**
225	147	Valentini Navrozidou, Olga Koukousioura, Sofia Doani, Peter Frenzel, Maria Triantaphyllou, Konstantinos Albanakis and Georgios Syrides **Ostracod-based environmental reconstruction of Lake Koronia, (Central Macedonia-Greece) during the Holocene**	**1066**

226	14	Constantinos Nefros, Gianna Kitsara, Constantinos Loupasakis and Christos Giannakopoulos **Rapid Detection of Landslides Triggered by Mediterranean Cyclones Using Google Earth Engine and Open-Access Data**	**1068**
227	112	Elisavet Nikoli, Paraskevi Nomikou, Evangelos Tasioulas, Christophis Koroneos, Kalliopi Sakkali, Georgios Koukourakis, Panagiotis Nastos, Varvara Antoniou, Dimitrios Emmanouloudis, George Pehlivanides and Aristidis Batis **Integrating Volcanic Geoheritage and Community Engagement: The Case of Nisyros aspiring UNESCO Global Geopark**	**1073**
228	293	Ioanna Nikolopoulou, Gian Maria Bocchini, Marco Roth, David Essing, Rebecca Harrington, Anna Serpetsidaki, Ioannis Fountoulakis, Christos Evangelidis and Efthimios Sokos **The 2024 March 29, 5.9 ML Strofades Earthquake (Greece) and its Seismic Sequence: Relocation, Focal Mechanism Solutions and Stress Inversion**	**1075**
229	141	Stefania Nisio, Sergio Madonna, Giancarlo Ciotoli, Gentili Francesco and Livio Ruggieri **Sinkholes, roads and exceptional transports, a risk to be assessed**	**1079**
230	108	Paraskevi Nomikou, Elisavet Nikoli, Evangelos Tasioulas, Christophis Koroneos, Kalliopi Sakkali, Georgios Koukourakis, Panagiotis Nastos, Varvara Antoniou, Dimitrios Emmanouloudis, George Pehlivanides and Aristidis Batis **Nisyros Geopark: A Living Laboratory of Volcanic Geoheritage in the South Aegean**	**1085**
231	129	Maria Margarita Ntona, Vasiliki Stavropoulou, Dimitra Lampropoulou, Eleni Zagana, Christos Pouliaris and Nerantzis Kazakis **Assessment of groundwater quality and seasonal dynamics in Chortiatis, northern Greece: Insights for sustainable resource management**	**1088**
232	24	Panos Ntontos **Evaluation of National Groundwater Monitoring Network at the Peloponnese, Greece**	**1094**
233	189	Efthymios Ntouros, Nikolaos Sofis, Maria Ellie Damoulianou, Margarita Iatrou, Tassos Grammatikopoulos, George Papaptheodorou and Stavros Kalaitzidis **Characteristics of REE mineralization in bauxite strata and in bauxite residue deposited into the Corinth Gulf, Greece**	**1100**
234	231	Grace Paez, Karla Vizuete, Alexis Debut, Mario Cruz-D'Howitt, Juan José Ortiz and Theofilos Toulkeridis **Characterization and timing of charcoal in geoheritage sites preserved by major volcanic destructions – Geoarcheological and paleo-environmental considerations in Ecuador**	**1103**
235	346	Gerasimos Papadopoulos, Ioanna Triantafyllou, Constantinos Siettos and Konstantinos Spiliotis **Foreshock-aftershock discrimination in real-time during the 2025 seismic cluster near Santorini volcano, Greece, based on earthquake statistics and complex networks theory**	**1108**

236	65	Theodoros Papadopoulos, Sofia Pechlivanidou, Michael Foumelis and Christos Pennos **Image-based grain size analysis of coastal sediments**	**1110**
237	85	Ermioni Eirini Papadopoulou, Stavros Proestakis, Christos Nikolaos Anagnostopoulos and Nikolaos Soulakellis **Development of a cartographic web application for monitoring the Corinth Canal using UAV data**	**1113**
238	236	Evdokia Papadopoulou and Alexandros Chatzipetros **An integrated approach using Remote Sensing and the Environmental Seismic Intensity Scale ESI 2007 for three major earthquakes in the Aegean region**	**1118**
239	185	Penelope Papadopoulou, Charalampos Fassoulas, George Iliopoulos, Georgia Kitsaki, Maria Kolendrianou, Elina Mikroulea, Charitakis Papaioannou, Dimitris Pattakos, Vaggelis Perakis, Maria Tsoni and Iro Tsimpri **Expertise on Specifications – Evaluation Criteria and Design of a Special Label for Local Agrotourism Products and Services: a cooperation for the benefit of four Greek UNESCO Global Geoparks!**	**1123**
240	232	Penelope Papadopoulou, George Iliopoulos, James Bendle, Kimon Christanis, Stavros Kalaitzidis, Eleni Liapi, Konstantinos Perleros, Nikolaos Soulakelis, Marianthi Tzortzi and Nikolaos Zouros **West Akrocheiras section: a pilot multi-proxy palaeoenvironmental analysis**	**1126**
241	238	Antonia Papageorgiou, Olga-Joan Ktenidou, Vasilis-Erion Pikoulis and Efthimios Sokos **Comparing broadband and strong-motion data using collocated sensors in the HP network, Greece**	**1132**
242	200	Elena Papageorgiou, Michael Foumelis, Pascal Dominique, Pavlos Bonatis, Daniele Raucoules, Marcello De Michele and Eleftheria Papadimitriou **Groundwater changes and induced seismicity influencing surface deformation in post-mining landscapes**	**1134**
243	134	Maria Papailiopoulou, Paraskevi Apostolopoulou, Vasiliki Stavropoulou, Christos Pouliaris, Nerantzis Kazakis and Eleni Zagana **Hydrochemical characterization of multi-layer porous aquifer of Larissos system, Peloponnese**	**1136**
244	288	Maria Papailiopoulou, Krystalia Chrisanthakopoulou, Vasiliki Stavropoulou, Christos Pouliaris, Nerantzis Kazakis and Eleni Zagana **Assessment of the groundwater vulnerability using DRASTIC method in Larissos watershed, Greece**	**1142**
245	132	Chara Papailiou, Maria Kolendrianou and Charalampos Fassoulas **RescueME, a Research Action that focuses on the enhancement of the resilience of coastal cultural landscapes in Europe.** **The case study of Psiloritis UGGp, Crete, Greece**	**1147**

246	89	Haritakis Papaioannou, Christos L. Stergiou, Spiros Staridas, Aristotelis Stagkikas and Georgia Kitsaki **Innovative Efforts in Geotourism: The Vikos-Aoos UNESCO Global Geopark**	**1152**
247	113	Dimitrios Papanikolaou, Paraskevi Nomikou and Danai Lambridou **Volcanism and the metamorphic core complexes of Rhodope and Cyclades**	**1157**
248	150	George Papathanassiou, Sotiris Valkaniotis and Maria Taftsoglou **The influence of stratigraphy for the generation of surface evidence of liquefaction phenomena; case study Piniada, Greece**	**1160**
249	365	Costas Papazachos, George Vougioukalakis, Stylianos Bitharis, Christos Pikridas, Michael Foumelis, Chrysanthi Ventouzi, Charalambos Kkallas, Eleni Karagianni, Domenikos Vamvakaris and Elena Papageorgiou **Monitoring the Santorini Volcano for 3 decades (1995–2025) by ISMOSAV and its role for the early detection of the 2011–2012 and 2024–2025 intra-caldera unrests**	**1162**
250	168	Angeliki Papoutsa, Stephanos Kilias, Nikolaos Zegkinoglou, Vasilios Pletsas, Rebecca Avoukatou, Paraskevi Nomikou, Paraskevi Polymenakou, Andrea Somogyi and Qasid Ahmad **Effects of boiling and seawater mixing on hyper-enrichment of antimony in active polymetallic seafloor massive sulfide hydrothermal diffusers at the Aegean Kolumbo volcano**	**1168**
251	116	Evaggelia Pappa, Costas Papazachos and Nikolaos Chatzis **VS30 Estimation from P-Wave Seismograms: Exploring a Frequency-Domain Approach for Stations Located in Sedimentary Basins**	**1174**
252	348	Melissinos Paraskevas, Ioannis Katsafados, Dimitrios Anastasiou, Maria Tsakiri, Paraskevi Nomikou and Costas Synolakis **Preliminary results of High-Resolution Microgravity Monitoring During the 2025 Santorini Unrest**	**1180**
253	3	Panagiotis Paschos **Stone bridges. Resilience to catastrophic phenomena**	**1184**

Volume F: Papers 251–300

A/A	EC	AUTHORS and TITLE	PAGE
254	266	Nikoleta Passali, Grigorios Aarne Sakellaris, Margarita Melfou, Lamprini Papadopoulou and Nikolaos Kantiranis **Mineralogy and Geochemistry of the polymetallic nodules of the Clarion Clipperton Zone, NE Pacific.**	**1187**
255	197	Adamantia Paschali Patouchi, Ioannis Panagiotopoulos and Dimitrios Vandarakis **A Pilot Study of Erosion in the Mavro Lithari Beach, part of the Highly Urbanized Coastal Zone of the Eastern Saronic Gulf, through the use of drone technology**	**1193**
256	352	Spyros Pavlides, Vassilis Karastathis, Evangelos Mouzakiotis, Sotiris Sboras, Alexandros Chatzipetros and Ilias Lazos **Active Faulting in Santorini and the recent intra-caldera (2024–2025) seismic activity along the Kameni-Fira Fault line**	**1197**
257	95	Spyros Pavlides, Sotirios Sboras, Ilias Lazos, Evaggelos Mouzakiotis and Vassilios Karastathis **The Fira fault, Santorini (Thera): morphotectonic, geomorphological and seismological evidence of fault activity**	**1199**
258	252	Eleni Pegioudi and Alexandros Chatzipetros **Geological routes on Ammouliani Island, northern Greece**	**1205**
259	286	Christos Pennos, Maria Perraki, Sofia Pechlivanidou, Rannveig Øvrevik Skoglund, Christos Salmas, Eleni Vasileiou, Yorgos Sotiriadis and Markos Vaxevanopoulos **Assessing Microplastic Pollution in Atzinolakas caves, Crete: Implications for Remote Karst Aquifers**	**1210**
260	97	Dimitris Pepas, Vassilios Marinos, Pavlos Nomikos and Charalampos Saroglou **Investigating the failure characteristics of several rock types using the Acoustic Emission technique**	**1216**
261	106	Argyrios Periferakis, Lamprini Troumpata, Aristodemos-Theodoros Periferakis and Konstantinos Periferakis **Coal and Asbestos Mining-Induced Pulmonary Pathologies: Radiological Diagnosis and Associated Challenges**	**1222**
262	295	Eftychia Peristeridou, Vasilios Melfos, Panagiotis Voudouris, Lambrini Papadopoulou, Jaroslav Pršek and Nikolaos Kantiranis **Mineralogical composition and mineral chemistry of the listvenite-hosted mineralization in Kato Vyrsini area, Thrace, Greece**	**1228**
263	107	Adonis Photiades, Isidoros Kampolis, Ioannis Vakalas and George Deligiannakis **The geological structure of the Myrtoan Sea islets**	**1234**

264	243	Serafeim Poulos, George Alexandrakis, Aikaterini Karditsa, Stamatina Lesioti, Markozanes Markozanes, Ioannis Katritsis and Nikolaos Kampanis **Assessment of the exposure of coastal sectors of the Greek Mainland to hazards induced by climate change, using the Coastal Hazard Wheel**	**1238**
265	88	Dimitrios Pyrgakis, Vasiliki Stavropoulou, Eleni Kaskani, Maria Papailiopoulou, Christos Pouliaris, Dimitra Lampropoulou, Eleni Zagana, Konstantinos Chalikakis and Nerantzis Kazakis **Hydrogeological and hydrochemical investigations of Selinous basin region**	**1242**
266	188	Dimitra Rapti **Assessment of natural and anthropogenic contamination of the sediments in the Sacca di Goro lagoon (Po river delta, northern Italy)**	**1248**
267	184	Dimitra Rapti **The role of hydrogeology in the sustainable exploration of shallow geothermal resources**	**1250**
268	192	Dimitra Rapti, George Papathanassiou, Sotiris Valkaniotis, Maria Taftsoglou and Riccardo Caputo **Liquefaction susceptibility in delta environments: the case of the Po delta area (northern Italy)**	**1252**
269	351	Georgia Rapti and Ourania Tzoraki **Investigation of legislation and tools for coastline demarcation: the coastline along the Kalamas delta in Thesprotia as a case study**	**1254**
270	109	Aikaterini Rogkala, Petros Petrounias, Panagiota P. Giannakopoulou, Petros Koutsovitis, Maria Kalpogiannaki, Paraskevi Lampropoulou and Harilaos Tsikos **Remnants of oceanic crust of Edessa ophiolite (North Greece): Petrographic and geochemical characteristics**	**1260**
271	283	Zafeiria Roumelioti and Nikitas Katsaitis **Shallow Depth P-wave Velocity Profiling Using Seismic Interferometry: The CORSSA Site**	**1265**
272	76	Artemios Roussos, Efstratios Kelepertzis, Zacharenia Kypritidou, Epameinondas Aivatzidis, Christos Drougas, Emmanouil Vassilakis, Panagiotis Voudouris and Nikolaos Zouros **Soil Geochemical Mapping on Lesvos Island, Greece**	**1271**
273	199	Aikaterini Maria Rozi and Zafeiria Papadimitriou **Pluto is lost!**	**1275**
274	198	Davide Russo and Riccardo Caputo **Rheological behaviour along the Hellenic Subduction Zone and the Adria-Eurasia continental collision**	**1277**

275	345	Dimitris Sakellariou, Ioannis Morfis, Isidoros Livanos, Alexandros Varesis, Stylianos Petrakis and Vasilis Kapsimalis **Marine geological-geophysical data may contribute to the understanding of the early 2025 seismic activity in the Santorini-Amorgos Zone**	**1285**
276	15	Dimitris Sakellariou, Ioannis Morfis, Dimitris Vandarakis, Isidoros Livanos and Ioannis Kourliaftis **Airborne and marine survey of the 8th June 2023 earthquake-triggered coastal collapse at Mylos Gialtron, North Evia: Contribution to the understanding of coastal zone vulnerability**	**1287**
277	339	Vassilis Sakkas, Christos Pikridas, Athanasios Ganas, Dimitrios Anastasiou, Panagiotis Elias, Stylianos Bitharis, Konstantinos Chousianitis, Konstantinos Raptakis, Vasilis Kapetanidis, George Kaviris, Stratos Liadopoulos, Nikolaos Voulgaris, John D. Alexopoulos and Evangelos Lagios **Continuous GNSS Geodetic Networks. A Powerful Tool for Monitoring and Understanding Complex Volcanic Environments: The Case of Santorini Volcano During the Seismic Crisis of 2024–2025**	**1293**
278	164	Vassilis Sakkas, Andreas Tzanis and Evangelos Lagios **Ground Deformation in Nisyros Volcano (Greece) Determined by GPS and SAR Interferometric Techniques**	**1295**
279	91	Myrsini-Ifigeneia Samothraki, Zacharenia Kypritidou and Ariadne Argyraki **Comparison of dermal bioaccessibility of potentially toxic elements contained in modern and ancient cosmetics**	**1300**
280	130	Panagiotis Sampatakakis, Marietta Theodoropoulou, Maria Tzima and Christos Christidis **Result of an inventory program (SAMY) of boreholes of various uses and their contribution to the water balances of groundwater systems.**	**1305**
281	334	Eirini Sardeli, Kyriaki Pavlou, Andreas Karakonstantis, Alexandros Athanasopoulos, Sokratis Pappas and Filippos Vallianatos **The 2025 Santorini Swarm: Spatiotemporal Distribution and Coulomb Stress Changes. Preliminary Results**	**1310**
282	363	Charalampos Saroglou, Vasileios Kallimogiannis, Athina Tsirogianni and Georgia Klironomou Stabilisation of volcanic rock slopes in traditional settlements. The case of Petra, Lesvos Island	**1315**
283	327	Loukas Savvelos and Nikolaos Zouros **Mapping pyroclastic formations at the Lesvos Petrified Forest, Greece the Akrocheiras hill pyroclastic sequence**	**1320**
284	359	Loukas Savvelos and Nikolaos Zouros **Mapping pyroclastic formations at the Lesvos Petrified Forest, Greece the Bali Alonia area pyroclastic sequence**	**1326**

285	133	Vanessa Schifano, Lorenza Li Vigni, Luciana Randazzo, Lorenzo Brusca, Sergio Bellomo, Sergio Calabrese and Walter D'Alessandro **Travertine deposits of Greece, a mineralogical and geochemical study**	**1332**
286	229	Vahram Serobyan, Taniel Danelian and Araiyk Grigoryan **The Upper Devonian sequence of the Noravank and Ertych geosites in Armenia: stratigraphy and geotouristic potential**	**1337**
287	74	Alkiviadis Sideridis, Evangelos Koutsoumpis, Katerina Mytakidou, Maria Boumpouka, Vasiliki Anevlavi and Paraskevas Rousopoulos **Marble as an educational fabric interweaving cultural and geological heritage, the case study of ancient Philippi site rock art, Kavala, Greece**	**1342**
288	42	Paraskevi Sklavounaki, Vasiliki Tzafaridi, Thomas Hasiotis, Stefanos Missias and Aristeidis Paleokrassas **First record of pockmarks in the North Aegean Trough**	**1344**
289	115	Loukia Skontovolou, Paraskevi Lampropoulou, Ioannis Baskoutas, Christina Raptopoulou, Panagiota P. Giannakopoulou, Aikaterini Rogkala, Aggeliki Kareli, Prokopis Savvatis and Petros Petrounias **Mineralogical and petrographic characterization of different limestones used as raw materials in the cement production**	**1347**
290	270	Emmanuel Skourtsos, Christos Filis, Emmanuel Vassilakis, Aliki Konsolaki, Evangelia Kotsi and Efthimios Lekkas **The role of the epikarst zone in the influx of water and the manifestation of humidity at the Holy Monastery of Kleiston, Mount Parnitha, Attica, Greece**	**1352**
291	52	Emilia Sofianska, Konstantinos Athanassoulis, Dimitrios Tarenides and Maria Gkagka **Composition and physicochemical properties of muds from the Evros river delta, Thrace district (Northern Greece) and their potential use in pelotherapy**	**1358**
292	222	Nikolaos Sofis, Efthymios Ntouros and Stavros Kalaitzidis **REE distribution in the b1 bauxite strata of the Parnassos–Giona Unit, Greece**	**1364**
293	225	Sophia Sotiropoulou, Michail Kalaitzis, Emmanuel Skourtsos, Dimitris Sakellariou and Haralambos Kranis **Plio-Quaternary tectonics and evolution of Southwestern Lesvos Island and Lesvos Basin, Greece: Transtensional deformation and relationship with the July 2017 earthquake activity**	**1367**
294	275	Kimon Soultanis, Konstantinos Soukis and Maria V. Triantaphyllou **Discovering the geoheritage of Skiathos Island (Northern Sporades, Greece)**	**1373**
295	5	Natalia Spanou **Cyclone Daniel's Impact: A Study of Geohazards in Meteora, Greece**	**1375**

296	284	Nafsika Ioanna Spyrou, Michalis Diakakis, Spyridon Mavroulis, Georgios Deligiannakis, Emmanuel Andreadakis, Christos Filis, Evelina Kotsi, Zacharias Antoniadis, Maria Melaki, Marilia Gogou, Katerina-Navsika Katsetsiadou, Eirini-Spyridoula Stanota, Emmanuel Skourtsos, Emmanuel Vassilakis and Efthymios Lekkas **Combining Ground and UAV Mapping for GIS-Based Assessment of Flash Flood Impact Severity: Application of the FFISS to the 2009 and 2020 Evia (Greece) Floods**	**1378**
297	163	Panagiotis Stamatis, Michaela Doukari and Kostas Topouzelis **Evaluating Airborne LiDAR and RGB Imagery for Accurate Shoreline Detection**	**1384**
298	303	Thomas Stavropoulos and Elissavet Feloni **Domestic Rainwater Harvesting Tanks' Sizing under Climate Change Conditions in Nisyros Island**	**1391**
299	340	Maria Stavropoulou, Konstantinos Soukis, Haralambos Kranis, Emmanuel Skourtsos and George Exadaktylos **Numerical modeling of fault genesis in the Santorini-Amorgos basin: an interplay of tectonic forces and magmatism**	**1396**
300	263	Christos L. Stergiou, Haritakis Papaioannou, Grigoria-Vasiliki Dimou, Eftychia Peristeridou, Margarita Melfou, Aristeidis G. Stamatiadis, Vasilios Melfos, Olga Koukousioura and Georgia Kitsaki **Sedimentary, Metamorphic, and Igneous Rocks in Harmony: Unveiling the rocky microcosm of the Vikos-Aoos UNESCO Global Geopark**	**1401**
301	240	Christos L. Stergiou, Grigorios-Aarne Sakellaris, Margarita Melfou, Vasilios Melfos, Lambrini Papadopoulou and Christos Stefanou **Insights from the mineralogy and mineral chemistry of the antimony mineralization at Philadelphio, Vertiskos Unit, Northern Greece**	**1407**
302	265	Spyridon Strongylis, Grigorios Aarne Sakellaris, Nikolaos Kantiranis and Alexandros Chatzipetros **Threshold Value Analysis in Geochemical Mapping for Gold-Only Vein-Type Mineralization**	**1413**
303	160	Maria Taftsoglou, Sotiris Valkaniotis, George Papathanassiou and Sotirios Argyroudis **Liquefaction risk assessment of airport infrastructure using geological data and remote sensing techniques**	**1419**

Volume G: Papers 301–358

A/A	EC	AUTHORS and TITLE	PAGE
304	159	Maria Taftsoglou, Sotiris Valkaniotis, George Papathanassiou, Vassilis Ntouvartzis, Dimitra Rapti and Riccardo Caputo **A correlation of liquefaction phenomena with the surficial geology of point bar deposits; case studies 2021 Damasi, Greece, 2023 Kahramanmaraş, Türkiye and 2010–2011 Christchurch, New Zealand**	1423
305	110	Onur Tan and Özlem Karagöz **Earthquake hazard implications for Lesvos (Midilli) and the surrounding region**	1427
306	60	Despoina Tektonidou, Panagiotis Voudouris, Constantinos Mavrogonatos, Federica Zaccarini, Vassilios Melfos, George Soulamidis, Ariadni Afroditi Georgatou, Evgenia Serfa, Degao Zhai, Manuel Keith, Alexandre Tarantola, Stylianos Tombros, Dimitrios Alifieris, Margarita Melfou, Evangelia Zygouri and Christos Kanellopoulos **The Megala Therma-Katsilemonas gold-silver mineralization, Lesvos island, Greece: a new alkalic-type epithermal deposit in Greece?**	1430
307	45	Dimosthenis Telemenis, Spyridon Bellas, Evangelos Vavouranakis and Emmanouil Manoutsoglou **Source rock potentiality of the late Miocene sapropelic layers of Gavdos island, Greece, based on geochemical and stratigraphic data**	1436
308	297	Alexia Theocharaki, Maria Nikopoulou, Stefanos Karampelas, Kantiranis Nikolaos, Stavros Oikonomidis and Lambrini Papadopoulou **Study of "Corundum" Samples from the Collection of the Mineralogical – Petrological Museum at Aristotle University of Thessaloniki, Greece**	1441
309	368	Tonbol K.M. **Climatic Variability and Wind Pattern Shifts in Alexandria: Twenty Years of Data to Guide Coastal Resilience in Northern Egypt**	1447
310	306	Aris Toska and Elizabeth Stathopoulou **The effect of microorganisms in the fossilization of skeletal material**	1448
311	224	Theofilos Toulkeridis, Aaron Addison, Silviu Constantin and Grace Tatiana Páez-Barrera **Ecuadorian candidates for the World Natural Heritage List – The Triple Volcano and Tayos caves**	1451
312	99	Maria Triantaphyllou, Elisavet Skampa and Vasiliki-Grigoria Dimou **A review of calcareous nannofossil biostratigraphic studies in the Hellenic territory (Greece): the contribution of the Micropaleontology Collection of the Laboratory of Historical Geology and Biogeosciences (NKUA)**	1456
313	181	Efstathia Tringa and Konstantia Tolika **Assessing Future Climate Change Risk to Cultural Heritage of Greece: A Case Study of Mycenae and Delos**	1460

314	228	Francesco Tripodi **Preliminary results of GEM (Gaseous elemental mercury) concentration in interstitial soil and free gases from Mt. Etna, Sicily**	**1462**
315	145	Fani Tripolitsiotou, Ariadne Argyraki and Hara Drinia **"Unfolding the Fold"- An Introduction to the Geology of Greece Through a Museum Kit by the Natural History Museum of Arsakeia Schools**	**1465**
316	249	Fani Tripolitsiotou, Hara Drinia and Ariadne Argyraki **Exploring Urban Geotourism Through Geomythology: A Geotrail from Faliro Bay to Vouliagmeni Peninsula, Attiki Region, Greece**	**1468**
317	304	Alexandros Troupakis, Elissavet Feloni, Kleomenis Kalogeropoulos and Andreas Tsatsaris **Exploring Social Perceptions of Water Scarcity and Local Water Resource Management in Greece: Insights from a National Survey**	**1471**
318	289	Dimitrios Tsagkas, Foteini Chalkiopoulou, Giorgos Kanakidis and Alexia Charmalia **Contribution of Engineering Geology to the rescuing and enhancing of cultural works and constructions. Case study: The fountain at the Antaeus and Gennaios Kolokotronis streets' junction in the Amalia Merkouri Square in Petralona.**	**1475**
319	274	Konstantinos Tsanakas, Alessia Sorrentino, Gaia Mattei, Pietro Patrizio Ciro Aucelli and Efthimios Karymbalis **Preliminary results on the mapping of uplifted marine terraces in the Laconic Peninsula, SE Peloponnese, Greece**	**1481**
320	272	Panagiota-Elpida Tsekoura, Marianthi Stefouli, Ioannis Vakalas, Eleni Vasileiou and Maria Perraki **Applications of satellite data analysis in the exploration of geothermal systems: The case of the Methana Peninsula, Greece**	**1487**
321	193	Anastasios Tsikrikis, Vassilis Marinos and Theodosis Papaliangas **The influence of mineralogy on the nondilatant friction angle of rock fractures**	**1493**
322	73	Dora Tsipra and Hara Drinia **Exploring Participant Experiences in a Geoconservation Program in Apano Meria, Syros island, Greece**	**1499**
323	56	Varvara Tsironi, Jean-Mathieu Nocquet, Athanassios Ganas, Efthimios Sokos and Ioannis Koukouvelas **Crustal Block Kinematics in Western Greece using geodetic data**	**1502**
324	278	Ioannis Tsodoulos, Efthimios Karymbalis, Maria Ferentinou, Andrew Green, Konstantinos Stamoulis and Christina Gallousi **Optically Stimulated Luminescence (OSL) dating of a shell midden layer at Umhlanga Rocks, Natal North Coast, South Africa**	**1505**

325	162	Maria Tsoni, Eleni Koumoutsou and George Iliopoulos **Chelmos- Vouraikos Unesco Global Geopark 2024: Advancing Conservation, Education, and Community Engagement**	**1511**
326	267	Theodora Tsourou, Eleni Anastasia Markoglou, Taniel Danelian, Constantine Parinos, Alexandra Gogou and Maria Triantaphyllou **Deep sea agglutinated foraminifera from the surface sediments of NE Mediterranean Sea**	**1514**
327	257	Theodora Tsourou, Nikolaos Sakoulas, Aggeliki Paraskevopoulou, Ifigeneia Perraki and Maria Triantaphyllou **Stratigraphic assignment of the Mesozoic shallow carbonate succession of Epos Mountain, Chios Island, Greece**	**1517**
328	269	Andreas Tzanis, Stylianos Chailas and Evaggelos Spyridonos **The geothermal prospect of the NW Lesvos Island, Greece: Three-dimensional magnetotelluric and gravity exploration**	**1519**
329	126	Marianthi Tzortzi, Federico Lugli, Thomas Tütken, Vasilis Golfinopoulos, George Iliopoulos and Andreas Darlas **Tracking mobility of Late Pleistocene ruminants using enamel strontium isotope analysis of teeth from Melitzia Cave, Mani Peninsula (Greece)**	**1525**
330	114	Nikolas Vagionakis, Konstantinos Diamantis, Maria Stavropoulou and Emmanouil Andreadakis **Application of UAVs in Rockfall Hazard Assessment and Mitigation Measures in the Vrachon Theatre, Byron Area, Greece**	**1528**
331	186	Dimitra Valavani, Penelope Papadopoulou, Peter Frenzel, Mauro Alivernini, Maria Tsoni, Maria Groumpou, Theodora Tsourou, Silvia Kolomaznik, Magdalena Kreuzheck and George Iliopoulos **Boosting Cave Ostracods Biodiversity: A case study from the Cave of the Lakes (Chelmos Vouraikos UNESCO Global Geopark, Peloponnese, Greece) with report of a new species of Trapezicandona**	**1534**
332	369	Valavani Eleni, Siarkos Ilias, Tzoraki Ourania **Overview of Legislation and Tools for Stram Flood Risk Assessment**	**1538**
333	328	Ilias Valiakos, Konstantina Bentana and Nikolaos Zouros **Conservation and Interpretation of Fossiliferous Sites in the Lesvos Island UNESCO Global Geopark**	**1539**
334	155	Sotiris Valkaniotis, Dimitra Rapti, Maria Taftsoglou, George Papathanassiou and Riccardo Caputo **Geomorphological mapping and lithological heterogeneity as tools for the assessment of liquefaction likelihood: Piniada Valley case study (central Greece)**	**1544**

335	211	Sotiris Valkaniotis, Maria Taftsoglou, Domna Samara, George Papathanassiou, Konstantia Tolika, Caterina Zei and Themistoklis Chatzitheodosiou **Development of a Medicane-induced landslide inventory with field and remote sensing data; 2023 Storm Daniel, central Greece**	**1547**
336	230	Kanella Valkanou, Efthimios Karymbalis and Konstantinos Tsanakas **Investigating the interaction between Flood Hazard and Soil Erosion in Northern Evia Island, Greece, using GIS Morphometric Analysis**	**1550**
337	216	Aikaterini Vardava, Vasilios Kyriakopoulos, Emmanuel Skourtsos and Christos Filis **Preliminary results on geological and hydrogeological conditions in Vilia, Attica, Greece**	**1555**
338	300	George Vargemezis, Panayiotis Tsourlos, Ilias Fikos, Eytychia Amanatidou, Prodromos Louvaris and Eleni Tzima **Contribution of Electrical Resistivity Tomography to the investigation of landslide conditions on slopes**	**1559**
339	233	Athanasios Varotsos, Konstantinos Filis, Vayia Xanthopoulou and Ioannis Iliopoulos **Mineralogical and Petrographic study of Hellenistic stamped transport amphorae from the area of Aigion, NW Peloponnese.**	**1563**
340	121	Effrosyni Varotsou, Paraskevi Nomikou, Dimitrios Papanikolaou, Serafeim Poulos, Ioannis Asteriou, Nikolaos Tsernotopoulos, Yannis Tsaparas, Ilias Koliopanos and Maria Petroulia **Morphotectonic Analysis and Geohazard Implications of the Messiniakos Gulf**	**1568**
341	34	Charalampos Vasilatos, Ifigeneia Megremi, Zoi Gkioka, Neofyta Theori, Erika Yessenia Cuida Lopez, Anca-Iulia Stoica and Athena Economou-Amilli **Assessment of Geo-environmental Status of Trichonis Lake, Greece: Mineralogy, Sedimentology, and Chemistry**	**1573**
342	333	Emmanuel Vassilakis, Efthymios Lekkas, Assimina Antonarakou, Panagiotis Nastos, Aliki Konsolaki, Evelina Kotsi, John Lialiaris and Michael Foumelis **Rockfall Source Identification and Risk Assessment at the Caldera of Santorini Island, Greece, based on Aerial LiDAR Data**	**1579**
343	190	Nikos Vavlas and Anastasia Kiratzi **Scaling Relations Between Earthquake Magnitude and Source Duration with Applications to Greece**	**1585**
344	83	Chrisanthi Ventouzi, Costas Papazachos, Charalambos Kkallas and Evaggelos Spyridonos **Microseismicity Monitoring of the Broader Stypsi Geothermal Field Area (Northern Lesvos Island, Greece) Using a Local Seismological Network**	**1591**
345	170	Amélie Viger, Haralambos Kranis, Athanassios Ganas and Alex Whittaker **Preliminary results on the interseismic deformation of the Argolis Peninsula, Greece**	**1597**

346	237	Paris Xypolias, Nikolaos Gerogiannis, Eirini Aravadinou and Konstantinos Apostolos Tsourtis **Spatial distribution and deformation of columnar calcite occurred in the high-pressure marbles of Cycladic Massif (Hellenides)**	**1603**
347	344	Isobel Yeo, Paraskevi Nomikou, Michael Clare, John Jamieson, Gaye Bayrakci, Anna Lichtschlag, Emma Gregory, Gemma Portlock, Sofia Della Sala, Alice Hopkins, Jacob Nash, Jaycee Favela, Katlin Adamczyk, Erin Bethell, Jennifer Spalding, Anna Katsigera, Sebastian Hölz, Konstantin Reeck, Martin Wollatz-Vogt, Hannah Zimmer, Jieyu Tan and Tom Kwasnitchka **Preliminary findings from expedition DY190 to the Christiana-Santorini-Kolumbo volcanic field in March 2025**	**1607**
348	320	Jiří Zahradník, Efthimios Sokos, Zafeiria Roumelioti and Fatih Turhan **Non-shear faulting of the 2025 Santorini-Amorgos (Anydros) earthquakes**	**1610**
349	177	Faedra-Tzesi Zanai, Penelope Papadopoulou, Nikolaos Depountis, Panagiotis Pelekis and George Iliopoulos **Integrating micropalaeontological, geotechnical and sedimentological data to reconstruct the palaeoenvironmental evolution of Mesolongi Lagoon**	**1616**
350	57	Avraam Zelilidis, George Iliopoulos, Angelos G Maravelis and Nicolina Bourli **The presence of nappes, in SW Peloponnesus peninsula, and the strongly metamorphic Plattenkalk series, in central south Peloponnesus and Crete Island, change the dynamic evolution of west and south Greece**	**1620**
351	67	Panagiotis Zelilidis, Alfred Uchman, George Iliopoulos, Panagiota Dalgkitsi and Nicolina Bourli **The trace fossil Zoophycos as an indicator for the Apulian Platform Margins evolution during Eocene in Lefkas Island.**	**1626**
352	302	Yanbin Zhu, Yongdong Wang and Nikolaos Zouros **New results on the Miocene gymnosperm fossil wood of Lesvos Petrified Forest, Lesvos Island, Greece, and its palaeoenvironment significance**	**1627**
353	48	Kerasia Ziazopoulou, Constantinos Loupasakis, Konstantinos Laskaridis, Michael Patronis, Angeliki Arapakou and Ioannis Kouseris **Utilizing ultrasound velocity measurements to estimate physicomechanical properties of carbonate ornamental rocks**	**1633**
354	178	Vasilis Zorapas and Olga Chalkiadaki **Spatial distribution of trace elements in four water districts of Greece during the period 2018–2023. Results from National Groundwater Monitoring Network Program of Greece**	**1637**
355	72	Elena Zoumpouli, Nicolina Bourli, Penelope Papadopoulou, Avraam Zelilidis, George Iliopoulos and Michalis Xanthakis **The actions of Kefalonia and Ithaca UGGp aiming at the promotion of the area through sustainable development**	**1644**

356	316	Nikolaos Zouros, Ilias Valiakos, Konstantina Bentana, George Grimpilakos, Eystratios Zgournios, Nikolaos Tsoukalas, Michail Georgitsis, Loukas Savvelos, Maria Agiasoti, Nikolaos Grammenopoulos, Ioannis Chorafas and Nikolaos Salamparchos **Excavations in the Lesvos Petrified Forest – A significant geo-conservation project alomg the Kalloni-Sigri road, in the Lesvos island UNESCO Global Geopark, Greece**	**1649**
357	356	Nikolaos Zouros **UNESCO Global Geoparks and Global Geoparks Network: Protecting, promoting and managing Earth heritage – Building Sustainable Communities**	**1655**
358	360	Nikolaos Zouros, Nikolaos Soulakellis, Ilias Valiakos, Konstantina Bentana, Giorgos Grimpylakos, Aggelos Lamprakopoulos, Parthenopi Panidou, Ermioni-Eirini Papadopoulou and Georgios Tataris **Lemnos Island Geosites and their Geotourism and Education Potential**	**1662**

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Assessing the management of Arkalochori EQ crisis in Crete, Greece under the implementation of RESILIAGE project in order to strengthen community resilience

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Introduction

It is well documented that only preparedness and prevention can support modern communities in respect to the earthquake risk. Being one of the most seismic prone areas in the world, Greece has invested a lot in the prevention of the impacts of future earthquakes and in the increase of preparedness of the structured and non-structured elements of our societies. Prevention is achieved through interventions and actions aiming at the identification of hazard zones, minimizing the exposures on the build environment and developing plans and regulations to manage crises. In most cases preparedness is achieved by strengthening and improving the behavior of material elements and infrastructures, the increase of knowledge regarding the hazard and its impact, as well as the improvement of the self-protection of citizens. In the past years, repeated Earthquake crises revealed that further improvements both on prevention and preparedness are necessary which can be made only if assessment of past crises' management is performed.

The earthquake of Arkalochori in central Crete is of one the most recent and most peculiar crises in Greece. The foreshock sequence started on the beginning of June 2021, just at the end of the COVID 19 crisis, and lasted almost three months having one strong earthquake of 4,8 R on July 24. The long foreshock period enabled the establishment of many seismic instruments in the broader area to monitor the phenomenon. The main shock took place early in the morning on September 21st, 2021 with a magnitude of 6 R scale and focal point 10 kms below the town of Arkalochori (Ganas et al. 2021). The earthquake took place along a well-known active fault in the area, the Kasteli fault (Fassoulas 2001) that has produced a swam of small eq in 1995 too (Delibasis et al. 1999). The town, that is one of the largest of rural Crete with a population of about 4000 inhabitants and many nearby villages were seriously affected with collapses and damages of old and more recent constructions, while even the city of Heraklion experienced moderate intensities with minor impacts. This was the first strong earthquake onshore Crete for more than a century (Papadopoulos 2011), and fortunately, there was only one human victim that was killed by a strong aftershock that happened few hours after the main event.

The most peculiar feature of this crisis was though the very long aftershock period that lasted almost a year with several events between 4 and 5 R scale. It was estimated that more than 4750 earthquakes took place on the broader area over a period of one year (Vallianatos et al. 2022) challenging the structural behavior of the buildings and the mental health of local population. The response of the Civil Protection mechanism was immediate with first responders and civil protection volunteers taking action soon after the main shock installing temporary camps at the Arkalochori and several other villages, and a more organized shelter at the Exhibition Center of Arkalochori few days after. The response of the local population was remarkable with hundreds of them arriving at Arkalochori from the first day to support the victims. This huge offer of volunteers created problems till a mechanism to manage them was set, but their contribution in compensating the burden of the local people and supporting their daily needs was invaluable even months after the earthquake.

The total toll of impacts counts more than 7000 houses heavily damaged by the main shock and its aftershocks with about 3900 of them to be demolished. Within these structures occur many local schools and churches. Apart from the first financial support that state provided soon after the earthquake to those affected by, the recovery process according to the locals failed totally to cover the needs of local societies (p.c. K. Gantatsios, president of "Elpis" the association of the victims of the earthquake 2024). Three years after the earthquake many families still live at preconstructed houses at the temporary shelter, from the 7000 applications for financial aid to repair houses that have been submitted only few tens have been elaborated by the relative services and the broader area presents images of abandonment and depopulation that was obvious at the recent census.

It is important to mention that the psychological burden of the local communities was not only increased by the long-lasting aftershocks but also from rumors and fake news that were circulated at social media but even the national

broadcasting channels. Rumors for stronger earthquakes were appearing after interviews or posts of "earthquake specialists" in national and international media. Fake news about the reasons of the long seismicity were repeatedly circulated connecting the earthquakes with the construction nearby of a new airport, the existence of a dam few kms away from the epicenters, but even the overfilling of a chapel under the runway of the new airport, that further increased the communication chaos.

The Arkalochori earthquake is a case study under RESILIAGE project funded by the Horizon Europe and coordinated by the Polytechnic of Torino, in which the University of Crete is among the 18 partners that aim to build sustainable resilient communities with local heritage drivers (https://resiliage.eu/). In general, recent crises and disasters have affected the European citizens' lives, livelihoods, and environment in unforeseen and unprecedented ways. These disasters are exacerbated by social inequality, lack of adequate information and technology, as well as economic and political crises, that reduce the effective preparedness and response. The main objectives of the project are thus focused on understanding citizen reaction in case of crisis, on cocreating new knowledge encompassing the local heritage drivers that make communities stronger and new tools that provide more accurate information and make it accessible through easy-to-use tools and finally, lightweighting solutions to support first responders and empower citizens in crisis and disaster situations. The project has defined five Systemic Resilience Innovation (SyRI) frameworks focusing on Adaptive Governance, Health and Wellbeing, Active Memory, Social Interaction and Inclusiveness and Socio-economic Resilience that are examined in five European territories facing variable risks. The Region of Crete is one of them addressed to the Active Memory in respect to the earthquake risk.

Hereby we present the results of two workshops that have been developed in Crete under RESILIAGE in order to assess the management of Arkalochori EQ crisis, to identify the cultural factors that may influence local resilience, to build local networks through synergies and collaborative actions, and to identify the gaps in the management crisis operation in order to develop proposals for future improvement.



Figure 1. Implementation of focus groups discussions during the first workshop of RESILIAGE at Cretan CORE Lab on May 2024.

Methodology

The RESILIAGE project has foreseen the organization of five Community Resilience Laboratories (CORE Labs) in five European territories that have suffered in the past from various disasters. These include the City of Trondheim in Norway that faces the risk of landslides (slow clay) and focusses on Health and wellbeing, the Famenne-Ardenne UNESCO Global Geopark in Belgium which has been affected by serious floods several years ago and focuses on Socio-economic resilience, the Region of Crete focusing on the earthquakes and the Active Memory, the Naturtejo UNESCO Global Geopark in Portugal which repeatedly experiences wild fires and focusses on Social Interaction and Inclusiveness and the town of Karsiyaka in Turkey that is facing risks form heatwaves and focusses on the Adaptive Governance.

The relative partners in these counties were obliged to set the CORE Labs by inviting local stakeholders. In Crete the Natural History Museum of Crete invited various stakeholders that are engaged in crisis management, or represent certain local target groups, education and communication organizations and citizens. The CORE Lab was thus formed by representatives of First Responders (National Center of Immediate Aid, Fire Brigade, and Volunteer groups),

Local Municipalities and the Region of Crete, Local Development Companies, The Church of Crete, Local Museums, Educational Centers, Local Cultural Clubs and Associations, Sport Clubs and Citizens.
Two onsite workshops were organized in Crete using the focus group methodology (Wilkinson 1998) associated by structured interviews and web questionnaires. In each workshop we used boards, concept, interaction and territorial maps, discussion recordings and the assistance of facilitators to gather and analyse local data in a qualitative manner. The first WS took place on the 21st and 22nd of May 2024 at the premises of Natural History Museum with 30 participants (Figure 1). The aims of the WS were to understand how the local community define its territory in terms of main environmental, historical, and cultural characterizations, understand how local community interacts with the environment from a cultural and historical perspective, gather local narratives of disaster risk reduction, extract cascade effects related to the historical, cultural and environmental factors that intervene in crisis response, and identify lessons learned related to the historical, cultural and environmental factors that intervene in crisis response, having as case study the Arkalochori EQ crisis. During the WS field visit to Arkalochori and nearby areas was organized to discuss with the local stakeholders and inhabitants there (Figure 2).



Figure 2. Pupils performing local dances during the visit of RESILIAGE partners at the preconstructed classrooms hosting the primary school of Arkalochori on May 2024.

The second workshop took place on the 7th of February 2025 again at the Natural History Museum of Crete with the participation of 19 people (Figure 3). This WS was aiming on mapping certain heritage elements recorded at the collective memory that can be used to strengthen local resilience and improve preparedness planning. Activities were thus focused on the co-mapping of local cultural elements supportive to strengthen citizen's resilience, on the co-creation of synergies and collaborations to safeguard those heritage elements through the establishment of a local agreement to safeguard them, and on proposing actions for the inclusion of local communities and vulnerable groups in the crisis management plans through the improvement of communications, the raise of awareness and sensitization of citizens and improving adaptive governance. In this second workshop more advanced methodologies and means were used like serious game, stickers, card boards, thematic maps etc. (Figure 4).
The data collected through these onsite CORE Lab activities were further elaborated by the research partners to step on and develop soft solutions and digital tools that will be evaluated by CORE Lab in a second phase of the project implementation.

Results

The main priority of Civil Protection is always the proper management of a crisis putting more efforts and means though on the response phase. Preparedness and prevention are less developed, whereas the recovery phase is the one that is less considered. RESILIAGE invests in the improvement of preparedness of local communities using their cultural assets and local heritage as potential drivers for establishing strong community resilience that can contribute in a more effective recovery phase. The inventory of these drivers and the assessment of crisis management is the main tool to identify the local needs, capacities and strengths, on which new tools and actions are being developed. The main results under the scopes of RESILIAGE project from the CORE Lab activities in Crete may be summarized as follows.



Figure 3. Co-mapping of cultural and natural heritage elements during the second workshop of RESILIAGE in February 2025.

Cultural bonds remain very strong in the island of Crete based on traditions and ethics dated back in time. Dances, songs, “mantinades” (local rhymes) and common celebrations under various occasions tightened relationships between communities and helped a lot the citizens to cope with the Arkalochori EQ consequences and long-standing impacts (Figure 2). The oral traditions and transfer of myths and stories between generations appears to be a key channel for the preservation of values and collective memory, connecting generations through shared narratives. The workshops also highlighted issues related to social ethics and values as well as the strong blood bond that highlights the importance of family ties that can influence social interactions and contribute to shaping the resilience of the community. At the same time, the workshops underscore that in each settlement there are dozens of reference points and monuments that connect residents to the place and history and offer relief and a source of encouragement in times of crisis, that must be preserved. The existence of social interaction spaces where people can meet and promote social interactions is an important foundation in the event of crises that must be maintained during the operation of temporary shelters.

In places where social interaction was intense, like in Arkalochori where a local sport club and the community were organizing various annual events, this played a crucial role in managing the crisis and offering immediate support to the victims. Their role was remarkable in providing food, immediate aim, managing and organizing the many volunteers and retaining community alive for long period. The engagement of young people in such social and community activities enforces the local cohesion and reduces the vulnerability of the communities. The local Church is also a very important actor in the post crisis phase because it has the organization and means to support immediately the victims especially at the rural areas, with material and immaterial aid. The existence of local volunteer groups is also a very important factor to manage a crisis as they can offer assistance to CP mechanism, support the victims and palliate the psychological burden.

The need for reliable information and proper communication, before but especially during the crisis, emerged as the top problem in the case of the Arkalochori earthquakes. The absence of reliable and timely information, as well as of corresponding official state communication channels, contributed to the increase in the spreading of fake news and rumors that increased further the stress of those affected. The battle with fake news and incorrect information was lost very early on as there was no way to deal with this on social networks. Throughout the long post-earthquake sequence, residents felt the lack of communication and information from the official authorities, a problem that was much more intense in elder people. In these cases, the Church could play an important role, if proper cooperation has been developed between the Church, the relevant scientific bodies and the State. To enhance disaster preparedness and response, it is crucial to adopt a more proactive and comprehensive approach to communication. This should include regular awareness campaigns before a disaster, accessible guidance for individual groups after a disaster and ensure that all relevant information sources are easily identifiable and accessible.



Figure 4. The concept board for the assessing of Crisis Management plan after the implementation of the second workshop of RESILIAGE in February 2025.

Regarding the crisis management it was obvious that the CP mechanism responded immediately after the main shock establishing shelters and providing support to the affected societies, following a well operational management plan. However, it is apparent that despite the comprehensive national policies and documentation, shortcomings exist in resources evaluation and cooperation mechanisms at the local level, which hinder effective disaster response. The strong building codes and regulations didn't prevent the numerous damages and destructions, mainly because of the weakness of the relative authorities to monitor and ensure their implementation. The case of Arkalochori EQs underpin the fact that in rural areas older infrastructure remains vulnerable, highlighting a need for reinforcement and modernization. In addition, and under the threat of Climate Change it was highlighted that disaster risk management plans are not integrated with climate adaptation strategies, causing missed opportunities to leverage ecosystems in disaster management.

Under this scope it was also stressed that detailed risk assessments are outdated and require revisions. The risk and vulnerability assessments identify key vulnerabilities within the adaptation plan, such as: socio-demographic factors (population distribution and vulnerable groups), impacts on buildings and infrastructure, and cultural heritage considerations. The assessment should thus consider agriculture, forestry, biodiversity, and fisheries, as well as references to vulnerable groups such as the elderly and disabled at the national or regional level.

The crisis management was further exacerbated by the fact that the financial legislation lacks detailed information regarding funding mechanisms available for disaster management. Alternative financing mechanisms for risk reduction are scarce, while state financial resources for risk reduction are insufficient, limiting the implementation of disaster resilience measures. The total failure of the CP mechanism in the recovery phase is indicated by the fact that three years after the crisis from the thousands of applications seeking state support to reconstruct the damaged properties, only few tens have been elaborated so far. This situation is not only socially inappropriate, but ethically and morally too as a large number of the Arkalochori victims were elder.

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