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Results and significance of the geological heritage workshop held on March 14, 2024

Korhan ÇAKIR[a*], Çağlar ASLAN[a], Sonay BOYRAZ ASLAN[b], Nazlıcan ASLAN[a], Devrim ERŞEN[a], Gültekin ERTEN[a], Nurdan YAVUZ[a] and M. Kerem SÖNMEZ[a]

[a] *General Directorate of Mineral Research and Exploration, Ankara, Türkiye.*
[b] *Geological Heritage Proctection Association, Ankara, Türkiye.*

Research Article

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ABSTRACT

To contribute these areas to the global literature, the UNESCO Turkish National Commission (UTMK), the General Directorate of Mineral Research and Exploration (MTA), the General Directorate for the Protection of Natural Assets (TVK), the Chamber of Geological Engineers (JMO), and the Geological Heritage Protection Association (JEMİRKO) have conducted various studies. In light of these studies, a workshop was held on March 14, 2024, to determine Türkiye's 100 Most Important Geological Heritage Sites and Key Geological Areas for National and International Visibility. In the list of the first 100 Geological Heritage Sites defined by the International Union of Geological Sciences in its 60th year (2022), two of our natural beauties were included: the Miocene-aged Cappadocia Ignimbrite Levels and the travertines of Pamukkale. As a result of the workshop, two geological beauties that were not previously included in the list (Nemrut Caldera, Bitlis, and Salda Lake, Burdur) came to the forefront, while Salda Lake in Burdur was inclued in the second 100 Geological Heritage Sites designated by the International Union of Geological Sciences. This publication has been prepared to raise awareness following the completion of the voting and scientific studies in these areas for future applications.

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1. Introduction

The joint workshop of the Turkish National Commission for UNESCO (UTMK), the General Directorate of Mineral Research and Exploration (MTA), the Turkish Association for the Conservation of Geological Heritage (JEMİRKO), the Chamber of Geological Engineers (JMO) and the General Directorate for the Protection of Natural Assets (TVK realized on March 2024 in the MTA's Sadrettin Alpan Conference Hall took great attention and participated in experts from different disciplines affiliated in universities, public and private sectors. The intense interest of nature lovers from all over Türkiye showed that geological heritage is an important richness of the country and it needs protection. The rich geological diversity in Türkiye is a result of complex geological events lasting about a billion years. During this long time, many geological features such as the remains of ancient continents and oceans, mountain formations and various fossil deposits have developed. The present morphology of Türkiye is a reflection of this long geological past. Mountains, valleys, caves and other geological formations all over the country

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**Corresponding author: Korhan ÇAKIR, korhan.cakir@mta.gov.tr*

are some examples of this heritage. The geological wealth in the country has been revealed as a result of many years of research by earthscientists and recently the national framework list of geological heritage has been published dependent on the inventory list of JEMİRKO (Kazancı et al., 2015). Not only earthscientists but also all nature lovers believe that these values should be protected and transferred to future generations. Geological heritage is the natural wealth that nature offers us and which cannot be replaced when it is lost (Digne Declaration, 1991). The conservation of geoheritage is of great importance not only for Türkiye but also for the world.

1.1. 14 March 2024 Workshop; A National Attempt to Choose Best Geosites and Key Geological Areas

The International Union of Geosciences (IUGS) launched the "the World's Best Geosites Project" in 2020 in cooperation with UNESCO and announced the first 100 including Cappadocia and Pamukkale sites from Türkiye (Figures 1, 2, 3). The second 100 was announced in August 2024 and Lake Salda has been included in the list. The IUGS also informed that the project will continue forming lists of 100 best geosites in every two years. Parallelly, the International Union for Conservation of Nature (IUCN) declared Resolution 74 focused on a possibly geological heritage project. According to the resolution 74, Key Geological Areas (KGA) having international importance for understanding the geological development of the world would promote (IUCN, 2025). The 14 March's workshop is a national preparatory action to these international initiatives in the leadership of JEMİRKO and the National Commissions for Unesco. The efforts and the desired result are to be a part of these important projects of the world.

In this workshop, which was a big step in terms of the conservation and promotion of the country's geological riches, two selections were realized by votes of experts for lists of both best geosites and KGA (Tables 1, 2). It is obvious that KGA and Best Geosites are not as alternatives to each other even some areas are observed in both lists i.e Cappadocia and Nemrut Volcano, however they could be candidates for both projects to the views of voters. In the workshop, it was emphasized that the international visibility was a useful tool for conservation of the geological heritage everywhere as governments were spending

Figure 1- Cappadocia Ignimbrite of Miocene which is in the first 100 list of Best Geosites of IUGS.

Figure 2- Pamukkale Travertines, Denizli (It is also in the first 100 list of Best geosites of IUGS).

Figure 3- Lake Salda, Burdur; the analogue of Mars in the Earth. Best Geosites in the second 100 list of IUGS.

much efforts to care on inscribed sites internationally. Therefore, NGOs and other institutions must be encouraged to participated in international projects such as Best Geosites and KGA.

2. Best Geosites and Key Geological Areas of the Country

In the evening of 14 March 2024, lists and ranks of the best geosites and KGA determined by votes of experts and representatives of public institutions were released together with a declaration (Tables 1, 2).

Table 1- Best Geosites of Türkiye and their Ranks.

1	Cappadocia and landforms, Nevşehir, Aksaray, Niğde
2	Pamukkale, Denizli
3	Nemrut Caldera, Bitlis
4	Salda Lake, Burdur
5	Meerschaum and deposits, Eskişehir
6	Meke Maar, Karapınar- Konya
7	Human footprints in Kula, Manisa
8	Oltu Stone and deposits, Erzurum
9	Denizli travertines and Homo erectus finding
10	Silicified trees of Çamlıdere (Ankara)
11	Ihlara valley, Aksaray
12	Kızılcahamam Güvem basalt columns, Ankara
13	Nallıhan N-Pg border fossiliferous coastal sandstones, Ankara, Bolu
14	Tuzluca Rainbow Rocks and Salt Cave, Iğdır
15	Cleopatra Beach oolites, Muğla
16	Sunken city of Kekova, Antalya
17	Patara beach dunes, Muğla
18	Spildağ pillow lavas, Manisa
19	Güvem Beşkonaklar fish and leaf fossils, Ankara
20	Karaca Cave, Gümüşhane
21	Ballıca Cave, Tokat
22	Giant mammal Baluchatherium and its beds, Çankırı
23	Holocene section of Yenikapı, ancient harbour and footprints, İstanbul
24	Derik Precambrian andesites (oldest volcanites), Mardin
25	Cennet-Cehennem depression dolines, Mersin
26	Köserelik-Baglum Ammonitiko rosso facies, Ankara
27	Dim Cave, Alanya, Antalya
28	Valla Canyon, Kastamonu
29	Menderes Massif Cine Yatağan Core Complex, Muğla, Aydın
30	Altıbeşik Cave, Antalya
31	Sofular cave, Zonguldak
32	Cayraz Formation (Eocene) and nummulite cemetery
33	Uludağ; mineral and mineral deposits and glacial forms, Bursa
34	Ulubey Canyon, Uşak
35	Messinian Salinity Crisis Gypsum, Adana
36	Hazro Anticline, Hazro- Diyarbakır
37	Kazdağı Massif, Çanakkale, Balıkesir
38	Paşalar Mammalian Fossil Bed, Bursa
39	Munzur Valley, Tunceli
40	Gondwana Thracian Glacial Sediments, Sarız, Kayseri
41	Neotetis island volcanites-Yemişliköy (Hisarköy and Çambu bay), Kastamonu
42	Salt Lake, Anatolia Ankara Konya
43	Saklıkent Canyon, Muğla
44	Güzelcehisar Upper Cretaceous column structures, Bartın
45	Terrestrial Pleistocene, Muş, Bitlis
46	Dardanelles, Çanakkale
47	Vanadokya-Bashkale landforms, Van
48	Lake Van and microbiolites
49	Obsidian deposits: Göllüdağ, Sarıkamış, Adilcevaz, Bingöl, Rize (Cagirankaya)
50	Göksu Delta, Mersin
51	Lake Bafa, Aydin, Muğla
52	Horma Canyon, Kastamonu
53	Yedigöller national park and landslide lakes, Bolu
54	The unquenchable flame of Olympos, Cirali, Antalya
55	Pleistocene beach rocks of Sinop
56	Tavas Oligo Miocene Break, Denizli
57	Akdeniz Yalı Stones, İskenderun
58	Alanya eclogites, Antalya
59	Kufeki stone (Heritage stone of İstanbul)
60	Lower Gökdere Ammonitico-Rosso facies, Gümüşhane
61	Seben Hocas Silicified tree fossils, Bolu
62	Central Sakarya, İzmir-Ankara-Erzincan Seam Belt
63	Dark Canyon, Kemaliye, Erzincan
64	Bosphorus
65	Dupnisa Cave, Kırklareli
66	Dursunlu Mammalian Fossil Bed, Akşehir, Konya
67	Sile eolinites, İstanbul
68	KAF Cripple at İsmetpaşa Train Station
69	Vitesliçeşme pillow lavas, Kırıkkale
70	Gölcük Maar, Isparta
71	Lake Van taracas and deformation structures
72	Altınboynuz, Golden Horn, İstanbul
73	Ancient marble quarries (Kuşini, Belevi, Selçuk, Marmara Island, İscehisar)
74	Büyük Menderes delta
75	Çankırı Salt Cave
76	Kızkumu coastal arrow, Muğla
77	Ancient mines (Keban, Gümüşhane, Küre, Demirköy)
78	Emet Borate deposits, Kütahya
79	Mazıdağ Mesozoic phosphate deposits, Mardin
80	Kızılırmak and its delta, Samsun
81	Tortum waterfall, Erzurum
82	Balya ancient mining operation, Balıkesir
83	Gökçeada Silicified tree fossils
84	Ayvaini Cave, Nilüfer Bursa
85	Erzurum-Oltu road rainbow rocks
86	Granite Columns, Kestenbol- Çanakkale

Table 1- continue

87	Manavgat River and Waterfalls, Antalya
88	Hereke Puddings (Triassic), Kocaeli
89	Çayırlı iron deposit (Contact metamorphism)
90	Gökçeada Yıldız Bay natural sculptures
91	Glacial lakes of the Cilo Mountains, Hakkari
92	Köprülü Canyon, Antalya
93	Çukurova caliche and lime shells, Adana
94	Bottomless Lake Jurassic Tree fossils
95	Hasanlar village giant exfoliations
96	Lefke Stone; old quarries in Osmaneli (Miras stone), Bilecik
97	Ilgarini Cave, Kastamonu
98	Historical Basda quarries, Urfa
99	Alidamı and Hakimhan Rudist accumulations, Adıyaman, Malatya
100	Aygör Maar and Lake, foot of Mount Süphan, Van
101	Tombolo (Sinop, Erdek, Kefken)
102	Tefra (K-Bentonite) Levels of Upper Devonian-Lower Carboniferous Age, NW Türkiye, Bartın
103	Avanos Kızılırmak taraçaları, Nevşehir
104	Sinap tepe and Kayıncak tepe Mammal Fossil Beds
105	Cendere anticline, Adıyaman
106	Levent valley and caves, Malatya
107	Seyhan-Ceyhan Delta, Adana
108	Kilop hardground and Neptunian dykes, Gümüşhane
109	Travertines of Antalya
110	Lake İznik Bursa
111	Elmalı polyesi, Antalya
112	Manisa fault mirror
113	Olistostrom (Nallıhan, Çördük, Elmadağ)
114	Economic Lignite deposits (Soma, Çayırhan, Elbistan, Yatağan)
115	Gediz Delta, İzmir
116	Çal Cave, Trabzon
117	Beşkonak-Selge Stone Forest Köprüçay Basin, Antalya
118	Çavuşlar obsidian workshop, Bingöl
119	Rock tombs Güldere valley, Karaman
120	Relocated city due to natural disaster: Palu-Elazığ
121	Ece Bay (Saros Gulf), ideal turbidite deposit, Çanakkale
122	Fragments of Mucur impact crater, Kırşehir
123	Acıgöl and Kalecitepe Maar, Nevşehir
124	Nargolu Maari, Nargolu, Aksaray
125	Gökgöl Cave, Zonguldak
126	Eğirdir Pleistocene colluvium
127	Kantasi Nemrutbasi lava flow, Tatvan, Bitlis
128	Bartın Stone Coals, Bartın
129	Beyşehir Lake, Konya
130	Lake Balık (volcanic control lake), Taşlıçay-Ağrı
131	Tuzlukçu plain (former lake plain), Konya
132	Kurum Valley-Silverhane
133	Gideros Bay, Kastamonu
134	Manyas Lake, Balıkesir
135	Zeytintaşı Cave, Serik, Antalya
136	Alacağızı Carboniferous (hard coal deposit), Zonguldak
137	Güldere (Karaman) Valley and Rock Tombs
138	Petroleum Sandstones, Adıyaman
139	Hasretdağı turbidite channels, Baskil, Elazığ
140	Cumayanı Cave, Zonguldak
141	Lake Akşehir, Konya
142	Ermenek Rock Tombs, Karaman
143	Ağaçbaşı Turfish-Trabzon
144	Cihanbeyli Obruk Plateau, Konya
145	Ulus Alıçlı Village Megabreches, Bartın
146	Barma Pike-Trabzon
147	Devonian-Carboniferous Brachiopoda fauna of Korucuk Village
148	Cretaceous-Eocene angular discordance of Mekece-Osmaneli road, Bilecik
149	Gilindire Cave, Aydıncık, Mersin
150	K-Pg Crossing, Şahinkaya Member, Trabzon
151	Priabonian Reference Section, Kovancılar, Elazığ
152	Karapınar Dunes, Konya
153	Telçeker Landslide (Noah's Ark) Doğubayazıt, Ağrı
154	Uluabat Lake, Bursa
155	Terrestrial Pleistocene, Muş, Bitlis
156	Sapanca Lake, Kocaeli, İzmit
157	Tuluntas Cave, Gölbaşı, Ankara
158	Çatak canyon, Kastamonu
159	Köprüçay Canyon, Isparta, Antalya
160	Yeşilırmak and its delta, Samsun
161	Sakarya river and delta, Sakarya
162	Devrekani K-Pg transition stack
163	Chora Maari, İncesu Kayseri
164	Kocaeli penepleni, Kocaeli
165	Zindan Cave, Isparta
166	Rupelian, Shattian Reference Section, Develi, Malatya
167	Akyatan Lagoon, Adana
168	Kocasu Delta, Bursa
169	Gökpınar Lake, Gürün, Sivas
170	Suğla Lake (lake-ova polyesi) Seydişehir-Konya
171	Yerköprü waterfall, Hadim- Konya

Table 2- Significant Key Geological Areas of Türkiye and their ranks.

ROW	Name of the areas
1	Cappadocia Ignimbirites
2	North Anatolian Fault Zone
3	Nemrut Volcano, Bitlis
4	Mount Ağrı stratovolcano
5	Narman Red Happiness Valley-Pliocene
6	Mut Miocene Basin
7	Eastern Anatolia Fault Zone
8	Lake Van
9	Hasandağı (Aksaray) stratovolcano
10	Kaçkar Glacier areas
11	CAF structures between Çerkeş-Gerede
12	Menderes Massif
13	Hazar Lake check-separate basin
14	Mount Erciyes (Kayseri) stratovolcano
15	Karacadağ-Diyarbakır lava plateau
16	Değirmentaş-Halevikdere Palaeozoic succession
17	Central Anatolian granites
18	Western Black Sea region (Bartın - Kastamonu) Terrestrial Çakraz For.
19	Lycian nappes
20	Eşen Neogene basin
21	Andirin Neogene Basin
22	Alaşehir Detachment fault
23	Upper Jurassic-Lower Cretaceous Taurus carbonate platform
24	Kocaeli Triad
25	Pull-apart basin volcanites-Erzincan
26	Nallıhan Mesozoic limestones folds
27	Ecemiş Fault
28	Bitlis Collision Zone
29	Aladağlar glacier area
30	Konya plain (Pleistocene Konya lake)
31	Şırnak asphalts
32	Alaşehir Graben
33	Tortum valley meandering structures
34	Hafik (Sivas) evaporite karsts
35	Kızıldağ Neotetis ophiolite sequence
36	Bitlis Massif
37	Kırkkavak Fault
38	Kırşehir Massif
39	Bartın -Amasra Aharlar village angular disharmony
40	Gollu Mountain volcanic complex (Kayırlı locality)

To achieve this satisfactorily result, a voting and selection board was formed and possible candidates taken from the inventory list of JEMIRKO were announced. Also, some new sites were offered and they were added to the list of potential candidates. In practice, each participant voted ten geosites and ten KGA ranking from 1 to 10. Selection/Voting committee worked hard and they declared the results (Tables 1, 2). When working of the selection committee, the rest of participants prepared the declaration.

Social media, national and local TVs, newspapers showed a great interest to the workshop and its results. It is possible to say that now Türkiye has formal lists of best geosites and Key Geological Areas.

3. Conclusion and Recommendations

International Union of Geological Sciences (IUGS) have published 200 best geosites and they will reach to 1000 in time. Global geological knowledge says that Türkiye can be in this list widely based on its geological richness. On the other hand, being in IUGS's lists are important both promotion of the natural conservation and development of geotourism. It is known well that geoturism is easy, cheap and preferable way for sustainable development of rural areas. Therefore, the workshop and its results would encourage us, the earthsciences of the country on participation of the global projects and international inscriptions. Less but not least, threats on geosites and even their destruction can increase as they were known much after the workshop and declaration. Thus, the relevant institutions should inscribe all geosites and geological heritages as natural assets in the current legislation.

4. The Final Declaration of the Geological Heritage Workshop on March 14, 2024, Ankara

The "Workshop on the Selection of Türkiye's the Best 100 Geological Heritage Sites and Key Geological Areas for National and International Visibility" was enthusiastically conducted on March 14, 2024, at the MTA Cultural Center Sadrettin Alpan Hall with the participation of 210 nature conservationists. The workshop was jointly organized

by the Turkish National Commission for UNESCO (UTMK), General Directorate of Mineral Research and Exploration (MTA), General Directorate for Protection of Natural Assets (TVK), Chamber of Geological Engineers (JMO), and the Turkish Association for the Conservation of the Geological Heritage (JEMİRKO). The participants included geologists, geomatic engineers, geographers, architects, urban planners, landscape architects, teachers, mining engineers, and professional tour guides from various universities, public sectors, and private sectors. The significant interest shown by nature enthusiasts from different provinces of Türkiye highlighted not only the value given to geological heritage but also the trust in the organizing institutions, while also indicating the legislation gap in geological conservation. This point was emphasized in the opening speeches and individual assessments.

Türkiye's rich geological diversity and significant geological heritage are results of its nearly one billion years of geological history. This geological wealth and extensive history are comparable to those of entire continents. The rocks forming the vast plains and elevated areas contain remnants of ancient continents and oceans, as well as traces of numerous mountain formations. Throughout this long geological process, extensive terrestrial and aquatic life forms have emerged and vanished, leaving behind their remnants as fossils. In the last five to six million years, Türkiye's current morphological framework has taken shape, revealing industrial raw materials, volcanic mountains, caves, canyons, and various landforms. This magnificent geological heritage, unveiled through long-term research by geoscientists, should be recognized and protected by local governments and citizens, and leveraged for development through geotourism and geopark initiatives. Geological heritage represents natural wealth that, once lost, can never be replaced. In addition to revealing the Earth's past, geological heritage offers answers to global issues like natural disaster recognition and climate change adaptation, which is why it is supported by UNESCO and other international institutions. The International Union of Geological Sciences (IUGS) launched the "Best Geological Sites of the World" project, announcing the first group, including Cappadocia and Pamukkale, in 2022. The second list of one hundred sites will be announced this August. The International Union for Conservation of Nature (IUCN) is also finalizing application criteria to select and promote "International Key Geological Areas" worldwide. With this workshop, Türkiye has demonstrated that it cannot remain distant from these international projects. The efforts and desired outcome are to be part of these significant global initiatives.

In the workshop, Türkiye's prominent geological assets were selected and prioritized as "geological heritage" and "key geological areas." The criteria for inclusion in the lists are being subjects of international publications and theses. Key Geological Areas and Geological Heritages are not alternatives to each other but have been identified considering the candidacy requirements for different projects. Efforts to add new areas to the list should continue.

Following the emergence of these lists, evaluations in the workshop concentrated on two key aspects, serving as a call to action for the relevant parties. Firstly, the reliable identification of geological heritage inventories from local areas to towns, districts, provinces, and the national level with the support of public and civil society. Secondly, equally important, is the registration and protection of geological heritages with necessary measures taken in collaboration with local governments. Nature is preserved through the contributions of individuals and all relevant parties, and as it is protected, our confidence in the future will increase. Respectfully announced to the public (In the name of Organizers Prof. Dr. Nizamettin Kazancı, Head of JEMİRKO).

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