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Geochemical and geological approach to the carbonate-hosted barite deposits in Dadağlı (Kahramanmaraş), Turkey

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Abstract

In terms of its geological structure, Kahramanmaraş is a complex region where various tectonic units are observed simultaneously. Many thrust and fault zones identified with the closure of the southern branch of the Neotethys Ocean are observed in this region. There are units existing to the Amanos Group in the vicinity of Dadaglı (Kahramanmaraş). Paleozoic aged rocks and Mesozoic aged carbonates are observed on them. There is vein type barite mineralization in the fracture lines of the Upper Triassic-Lower Jurassic Küreci dolomitic limestones in the north of Dadağlı. Paragenesis consists of galena, sphalerite, pyrite, smithsonite, calcite and quartz, individually. The mineralization is roughly 1 m thick and 200 meters long. The BaO value amounts to a peak of 65.07% in the specimens gathered from the ore zone. Although the ore zone is poor in SrO, it is rather rich in SiO_2. Barite samples from the study area exhibit similar many other vein type barite deposits with SrO% contents. Since this region is extremely close to both East Anatolian Fault (EAF) and suture belt of Taurides and Arabian Platform, it is considered that EAF may have an effect on barite formation in fractures and cracks.

1. Introduction

Barite ($BaSO_4$) is an essential industrial raw material because it is an intense mineral. Barite, which generally observed in marine environments [1-2], is still involved in the paragenesis of Pb, Zn, Cu and Au deposits in low, medium and high sulfidation classes [3-4]. Barite-bearing fluids occur in sedimentary processes, specifically in marine environments, including magmatic [5], hydrothermal [6] and metamorphic [7] fluids [2, 8-9]. For barite formation: fluid cooling or bacterial process [10], intense liquid-rock interaction [11] and mixing of two or more liquids [12] are effective.

Turkey's important barite deposits were formed as a result of the Alpine and Hercynian Orogeny [13]. For this reason, barite mineralization is located in major tectonic belts. Among these deposits, the Isparta barite deposits, which have the largest distribution, are observed in Paleozoic aged carbonate and pelitic rocks in the Western Taurus [14-19]. Cansu and Öztürk [20] explained the formation and origin of barite deposits associated with Paleozoic sediments located in both the Tauride-Anatolide belt (Şarkikaraağaç, Hüyük and Tordere deposits) and the Arabian platform (Şekeroba and Önsen deposits, Kahramanmaraş). The barite mineralization observed in the Dadaglı region is very close to this district.

In this paper, we present geochemical data obtained from Dadağlı barite mineralization using X-ray fluorescence (XRF) methods.

2. Material and Method

In terms of its geological structure, Kahramanmaraş is a complex region where various tectonic units are observed simultaneously. Many thrust and fault zones identified with the closure of the southern branch of the Neotethys Ocean are observed in this region [21]. Suture belts were formed by both the closure of the ocean and the convergence of the Tauride and Arabian plates [22]. With the depletion of the ocean floor, allochthonous units were thrusted onto the Arabian platform in the south and suture belt and suture belts were formed between these two continents [23]. Rigo De Righi and Cortesini [24] and Gül [25] divided the tectonostratigraphic units in the Southeastern Anatolia Region into orogenic belts.

The Dadağlı barite mineralization is situated in the margin fold belt of the Arabian Platform in the south of the Taurus Orogenic Belt (Figure 1). It has been stated that in the Middle Miocene, when the Arabian Plate collided with the Anatolian Plate in this region, allochthonous units emplaced in the shallow Miocene basin and caused the basin to partially turn into land [26]. Gül [27] stated that the collision of the Anatolian and Arabian plates took place in the Upper Cretaceous and a compressional regime was active in the region during the Paleocene-Early Eocene period. Yılmaz and Yiğitbaş [28] stated that as a result of the movement of the Arabian continent towards the Anatolian plate between the Upper Cretaceous-Miocene, the region gained a nappe character. In this tectonically active region, rock groups of different origins are observed together. Rocks belonging to the Amanos Group are widely observed in the Dadaglı region.

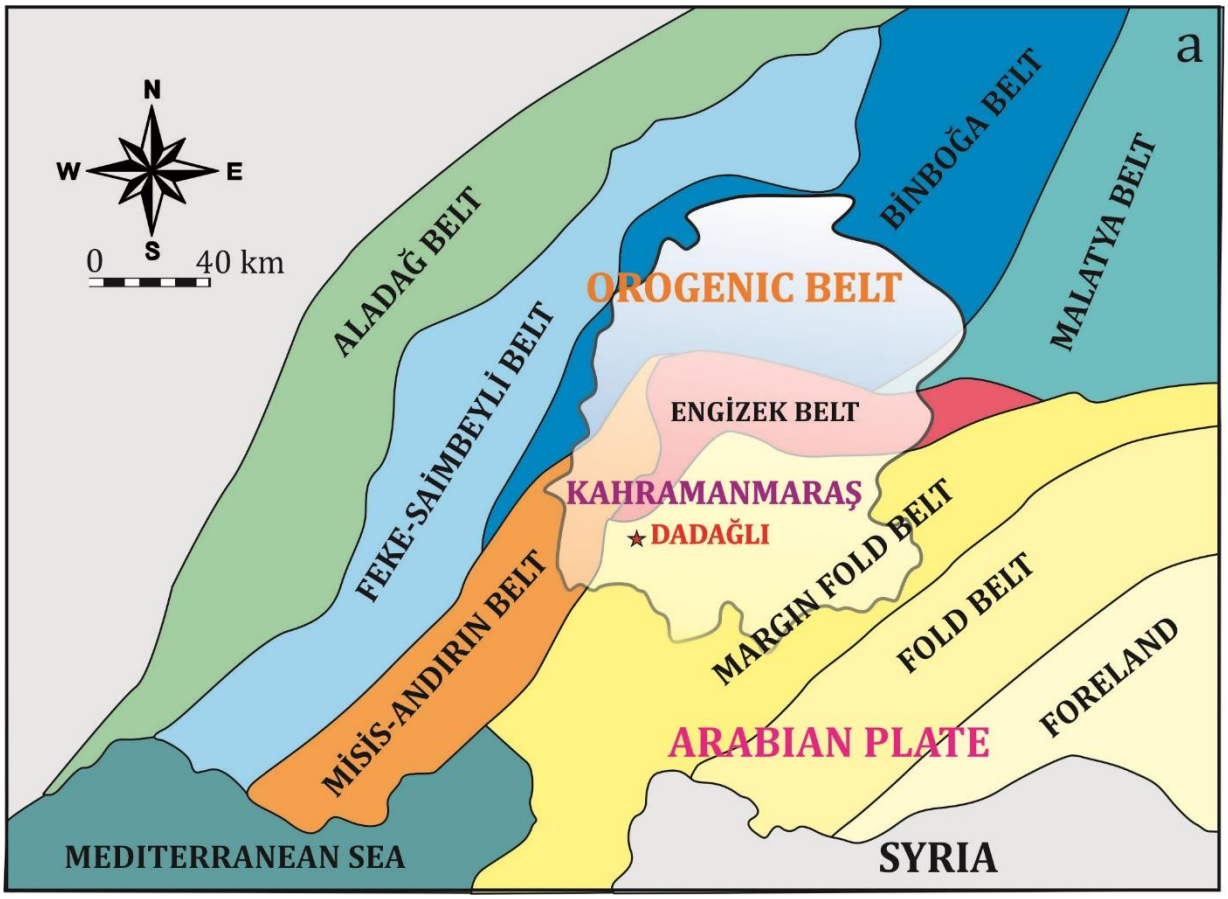

Figure 1. Tectonic location of the study area [25]

2.1. Geological background

Seydişehir formation forms the basement of the study area. The unit mainly consists of shale, siltstone, metasandstone and quartzite [29-30]. Lithologies of this unit crop out in Altınova, Dadaglı and Hopurlu regions (Figure 2) respectively. On this unit, Mesozoic aged carbonates are overlying with angular unconformity. Küreci dolomitic limestones and Karadağ limestones are observed around Önsenhopuru and Dadağlı (Figure 2) districts. These units of Amanos are overlain by Upper Miocene aged basalts with angular unconformity [31-32]. Quaternary alluviums represent the youngest lithologies of the region.

The study area is very close to the East Anatolian Fault (EAF), which is one of the most important faults of Turkey in terms of tectonics. For this reason, the origin of the deformations in this region may be the EAF as well as the tectonic structures before the formation of the EAF. This warning was made for the importance of factors

such as faults and joints, which are effective in the formation of ore in the region. Because many faults are observed in the region (Figure 2). The rocks were deformed by the effect of these faults. Depending on the movement of fluids in deformed rocks, vein type mineralizations are found. Around these veins, crushed zones and altered zones have developed in the rocks.

The study area is very close to the area where the southern branch of the Neotethys Ocean was closed [21] and as a result Tauride and Arabian plates converged to form suture belts [33-38]. It should also be taken into account that this region has undergone a north-south oriented compression period.

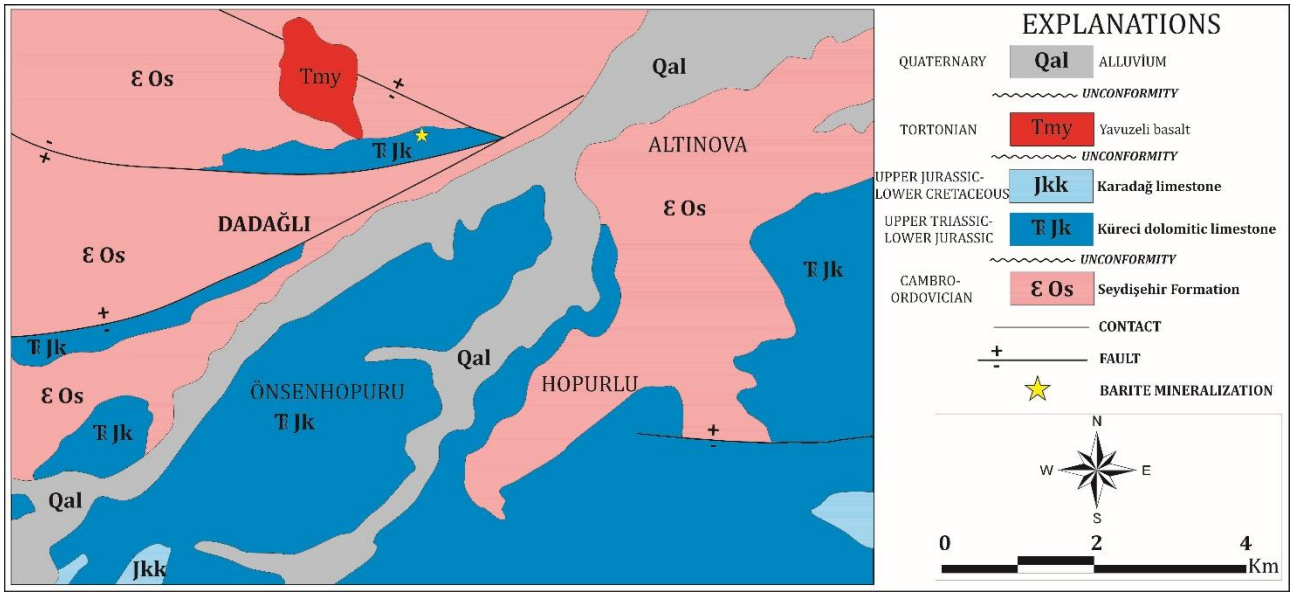

Figure 2. Geological map of the study area [39]

2.2. Mineralization

In Dadağlı region, Upper Triassic-Lower Jurassic Küreci limestones overlie the Paleozoic basement with angular unconformity. Vein type barite mineralizations are observed in the limestones in the north of Dadadağlı (Figure 3).

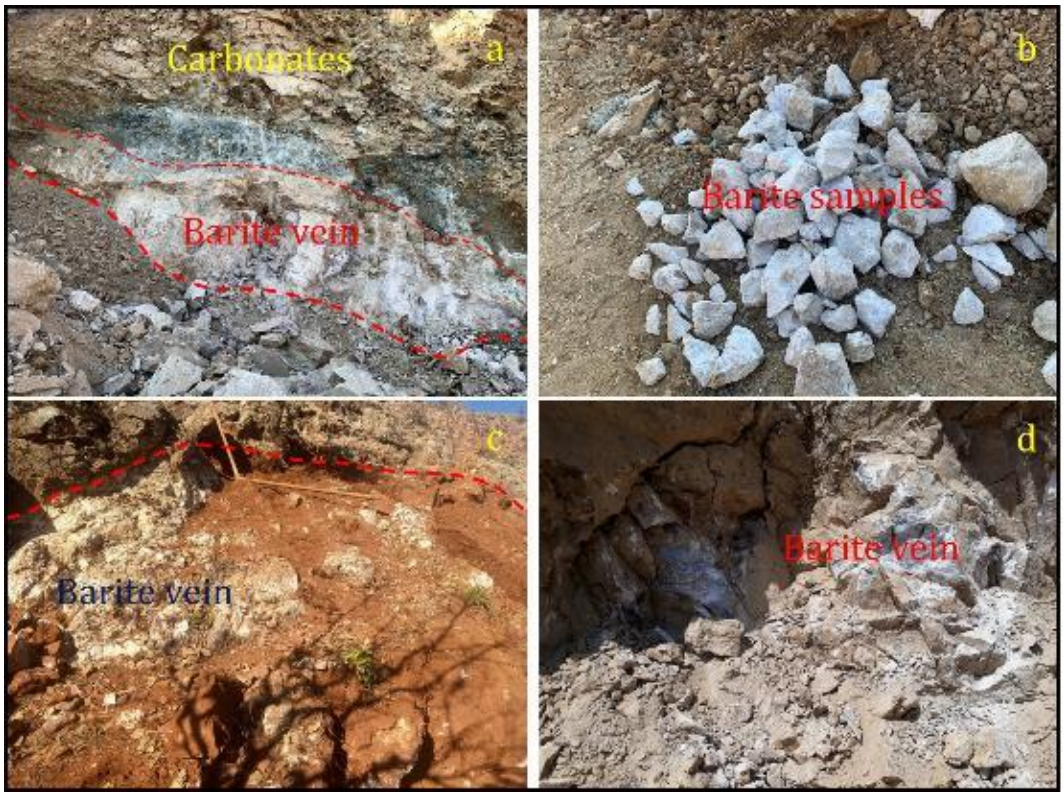

Figure 3. General view of barite mineralization.

Barite mineralization is observed in faults and joints of carbonate units. These fault zones are easily distinguished by their brecciated texture. In addition, altered zones are observed in some areas along the ore vein.

In the mineralization with epigenetic formation, quartz, calcite and smithsonite are still observed along with galena, sphalerite and pyrite, respectively. In the ore petrography, it was determined that quartz veins cut the calcite veins and the sphalerites were transformed into smithsonite (Figure 4 a,b,c). Pyrites are commonly converted to goethite (Figure 4b) and galenas to serousite (Figure 4d). Galena and sphalerites are generally anhedral and scattered, while smithsonites are euhedral.

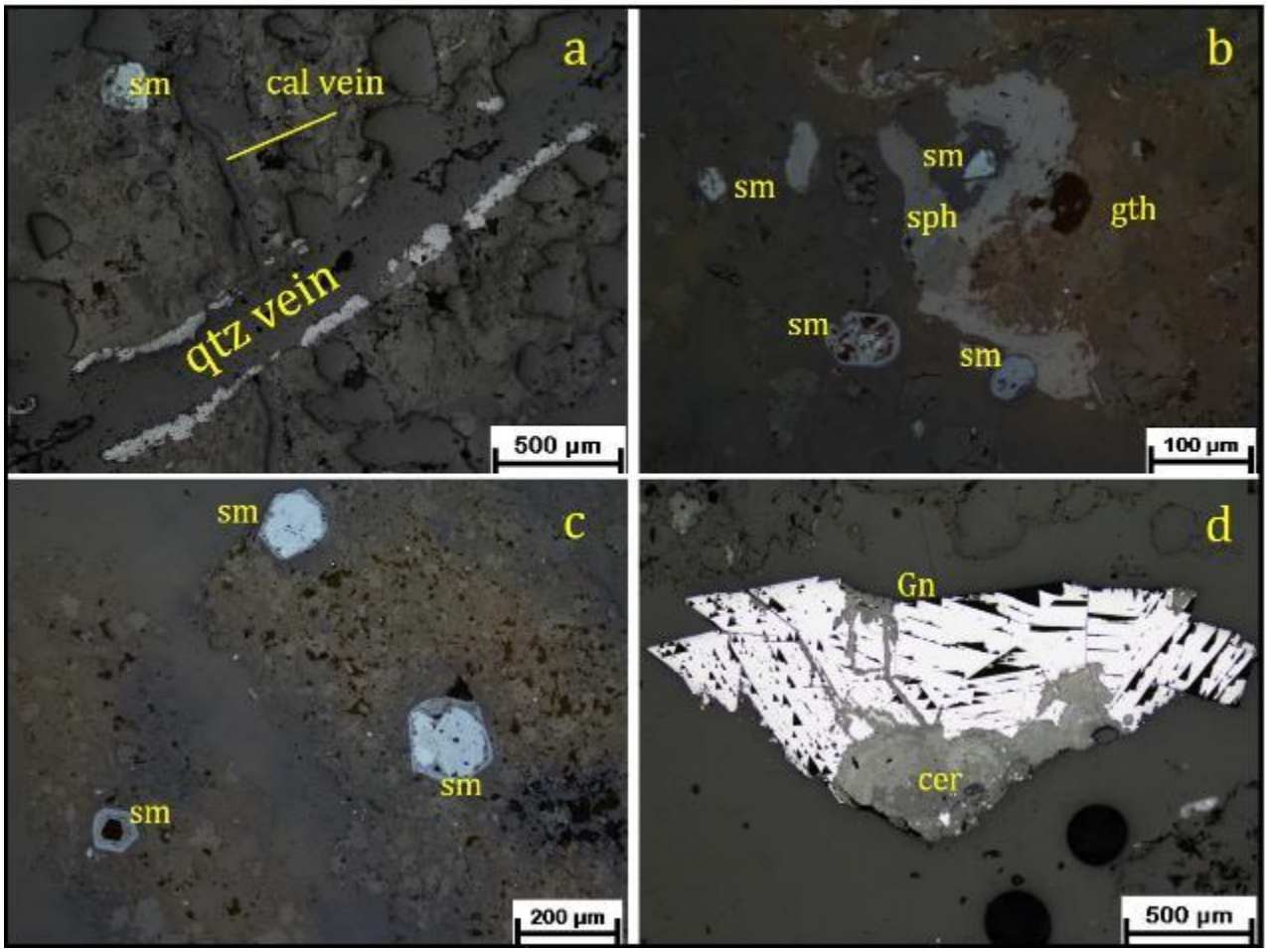

Figure 4. Microscope images of the polished sections. Abbreviations: (sm) smithsonite, (cal vein) calcite vein, (qtz vein) quartz vein, (sph) sphalerite, (gth) goethite, (Gn) galenite, (cer) cerussite

3. Geochemistry

In this region, 8 samples were taken and geochemical analyzes were made. Major oxide element analyzes were carried out in ITU-JAL. Analysis results are given in Table 1.

As showed in Table 1, BaO is between 0.49-65.07% (average 29.52%) and SrO is between 0.06-1.78% (average 0.64%) in the ore zone. Some of the compiled samples are rather rich in SiO_2. CaO is between 0.26-12.77% (average 2.88%) and Fe_2O_3 is between 0.12-15.97% (average 4.15%). The high Fe_2O_3 values in some barite samples are related the presence of ferrous minerals (pyrite and goethite). In K1, K2, K5, K6, and K7 samples, the high SiO_2 composition, which indicates quartz gangue in barite ore as observed in polish sections.

Samples have low Al_2O_3, MnO, Na_2O, K_2O, TiO_2 and P_2O_5 contents respectively. The presence of strontium oxide in barite deposits can be used to determine and compare the genesis of the deposit. Barite samples from the study area exhibit similar many other vein type barite deposits.

4. Discussion

Important barite deposits are both sedimentary stratiform, hydrothermal and biogenic deposits [40]. In sedimentary deposits, sulfur minerals are not involved in paragenesis [41-43]. In hydrothermal formation, it is similar to the sedimentary exhalative (SEDEX) model containing some sulfate minerals and base metal sulfides [44]. Also known as 'Mississippi Valley type mineralization', epigenetic barite ore occurs in platform carbonate

sequences [45]. It has been suggested that basin fluids with a temperature of <200 °C and concentrated along the faults cause to Mississippi Valley type deposits of lead, zinc and barite [46-48].

Table 1. Major oxide analysis of barite mineralization

Formula	K1	K2	K3	K4	K5	K6	K7	K8
Na_2O	0,13	0,89	0,48	0,48	0,05	0,33	0,00	0,38
MgO	3,95	0,82	0,20	0,05	0,42	0,13	0,61	0,12
Al_2O_3	1,80	22,70	1,27	0,25	1,28	0,45	1,72	0,65
SiO_2	38,79	42,44	6,62	2,32	87,74	32,18	86,78	9,28
P_2O_5	0,27	0,66	0,03	0,00	0,02	0,04	0,03	0,03
K_2O	0,47	5,51	0,10	0,00	0,24	0,10	0,28	0,10
CaO	12,77	0,26	1,13	0,61	1,46	2,23	2,32	2,31
TiO2	0,13	3,97	0,12	0,01	0,06	0,16	0,06	0,10
MnO	0,20	0,03	0,02	0,00	0,81	0,00	1,84	0,07
Fe_2O_3	2,41	15,97	0,30	0,12	0,86	11,38	1,63	0,53
SO_3	8,56	0,13	26,77	28,44	1,47	17,43	0,31	25,58
BaO	16,71	0,49	60,97	65,07	2,51	31,07	0,96	58,41
Cr_2O_3	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00
SrO	0,57	0,06	1,12	1,78	0,06	0,57	0,02	0,94
LOI	13,22	5,86	0,83	0,81	2,96	3,89	3,38	1,47
TOTAL	**99,99**	**99,80**	**99,96**	**99,94**	**99,94**	**99,97**	**99,93**	**99,97**

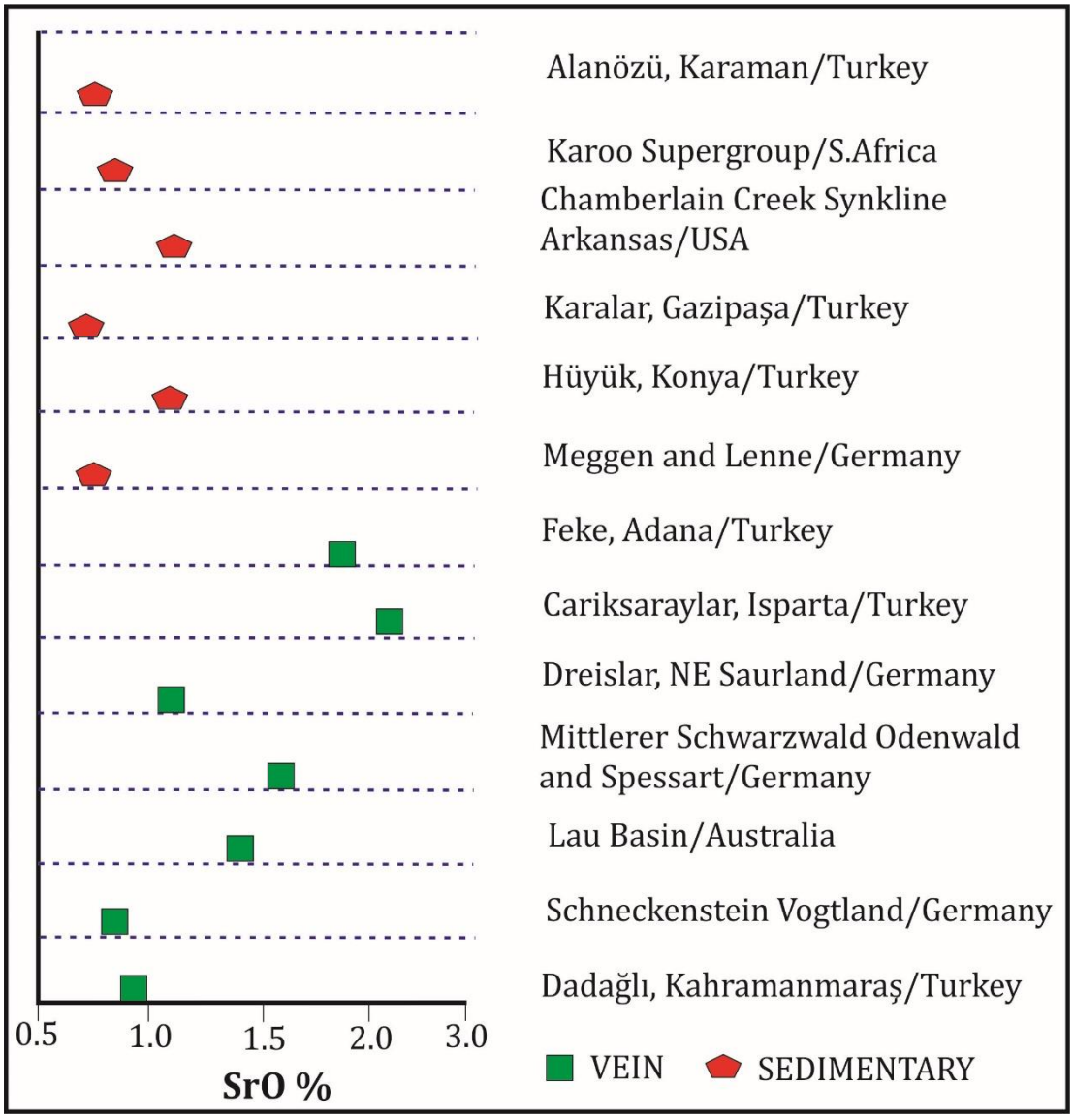

Figure 5. Several deposit types of barite, percentage of strontium oxide amounts [49]

In Turkey, there are many barite deposits associated with carbonate rocks in the Taurus Orogenic belt and the Arabian Plate. In the paragenesis of these barite deposits, chalcopyrite is sometimes found together with galena and sphalerite. Since this study area is very close or related to the barite formation belts described above, the data obtained is important for the Turkish barite deposits.

5. Conclusion

The Dadağlı region is located within the margin fold belt of the Arabian plate. There is vein type epigenetic barite mineralization in the Mesozoic aged carbonates from the Amanos Group units here. The mineralization observed in the fractures and cracks of the carbonates in this region is 200 meters long, with an average thickness of 1 meter. Corresponding to the preliminary data, lead-zinc minerals and their carbonated forms are observed in the ore paragenesis. Major oxide results indicate a mineralization that is poor in Sr but rich in silica. Rich Al_2O_3 values in specimens with poor BaO content may be associated with argillization in fault zones. The positive correlation between SO_3 and BaO in the analysis results is remarkably strong to be ignored.

Since this region is extremely close to both EAF and suture belt of Taurides and Arabian Platform, it is considered that EAF may have an effect on barite formation in fractures and cracks.

In order to elucidate the formation of the barite deposit, isotope studies, trace element and Rare Earth element analyzes as well as liquid inclusion studies should be performed. Apart from the fluid inclusion study, the host rocks should not be ignored in other studies. Each analysis made should be correlated with the host rock.

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Conflicts of interest

The authors declare no conflicts of interest.

References

1. Goldberg, E. D., & Arrhenius, G. O. S. (1958). Chemistry of pelagic sediments. *Geochimica et cosmochimica acta,* 13, 153–212.
2. Griffith, E. M., & Paytan, A. (2012). Barite in the ocean-occurrence, geochemistry, and palaeoceanographic applications. Sedimentology 59, 1817–1835.
3. White, N., & Hedenquist, J. (1995). Epithermal gold deposits: Styles, characteristics and exploration. EG Newsletters, 23, 1, 9–13.
4. Wang, Le, Ke-Zh Qin, G.-X. & Song, G.-M. Li. (2019). A review of intermediate sulfidation epithermal deposits and subclassification. Ore Geology Reviews, 107, 434–456.
5. Williams-Jones, A. E., Samoson, I. M., & Olivo, G. R. (2000). The genesis of hydrothermal fluorite-REE deposits in the Gallinas Mountains, New Mexico. Economic Geology. 95, 327–341.
6. Hanor, J. S. (2000). Barite-celestine geochemistry and environments of formation. Reviews in Mineralogy and Geochemistry, 40 (1), 193–275.
7. Kontak, D. J., Kyser, K., Gize, A., & Marshall, D. (2006). Structurally controlled vein baryte mineralization in the Maritimes Basin of Eastern Canada: geologic setting, stable isotopes, and fluid inclusions. Economic Geology, 101, 407–430.
8. Baioumy, H. M. (2015). Rare earth elements, S and Sr isotopes and origin of barite from Bahariya Oasis, Egypt: Implication for the origin of host iron ores. *Journal of African Earth Sciences,* 106, 99–107.
9. Monnin, C. & Cividini, D. (2006). The saturation state of the world's ocean with respect to (Ba, Sr)SO4 solid solutions. *Geochimica et cosmochimica acta*, 70, 3290–3298.
10. Pfaff, K., Hildebrandt, L. H., Leach, D. L., Jacob, D. E., & Markl, G. (2010). Formation of the Wiesloch Mississippi Valley-type Zn-Pb-Ag deposit in the extensional setting of the Upper Rhinegraben, SW Germany. Miner. Deposita, 45 (7), 647–666. https://doi. org/10.1007/s00126-010-0296-5.

11. Marchev, P., & Moritz, R. (2006). Isotopic composition of Sr and Pb in the Central Rhodopean ore fields: inferences for the genesis of the base-metal deposits. Geologica Balcanica, 35 (3–4), 49–61.
12. Valenza, K., Moritz, R., Mouttaqi, A., Fontignie, D., & Sharp, Z. (2000). Vein and karst barite deposits in the western Jebilet of Morocco: fluid inclusion and isotope (S, O, Sr) evidence for regional fluid mixing related to Central Atlantic rifting. Economic Geology, 95 (3), 587–606.
13. Okay, A. I. (2008). Geology of Turkey: A Synopsis. Anschnitt 21, 19–42.
14. Ayhan, A. (1986). The properties of barite occurences in the Lower-Middle Cambrian sedimentary sequences around Huyuk (Konya). Selçuk University Engineering Faculty Bulletin. 1, 20–45.
15. Ayhan, A. (2001). Stratiform Barite Deposits between Şarkikaraagaç (Isparta) and Hüyük (Konya) in Sultandag Region, Turkey. Chemie der Erde Geochemistry, 61, 54–66.
16. Çopuroğlu, İ. (1994). Mineralogical-petrographical and genetic exploration of Karalar- Gazipaşa (Antalya) galenite-barite deposit. Bullet. Min. Res. Explor. 116, 29–36
17. Cengiz, O., & Kuşçu, M. (2002). Geochemical properties and the source of barite deposits between Şarkikaraağaç (Isparta) and Hüyük (Konya). Bulletin of The Mineral Research and Exploration, 123–124, 67–89.
18. Cengiz, O., Uçurum, A., & Muchez, P. (2008). Determination of the source of Sarkikaraagaç (Isparta), Hüyük, Beysehir (Konya) ve Gazipasa (Antalya) barite deposits by fluid inclusion and S, O, C, Sr ve Pb isotope studies. The Final Report of TUBITAK Project 104Y032, p. 211.
19. Elmas, N., Kumral, M., Suner, F., & Taşdelen, S. (2012). Stratiform barite deposits hosted in metamorphic assemblages of Dinek and surrounding regions, Isparta, Turkey. *Journal of Asian Earth Sciences*, 48, 150–159.
20. Cansu, Z., & Öztürk, H. (2020). Formation and genesis of Paleozoic sediment-hosted barite deposits in Turkey. Ore Geology Reviews, 125, 103700.
21. Şengör, A. M. C., & Yılmaz, Y. (1981). Tethyan evolution of Turkey, a plate tectonic approach. Tectonophysics 75, 181–241.
22. Robertson, A. H. F., & Dixon, J. E. (1984). Introduction: aspects of the geological evolution of the Eastern Mediterranean. In: Dixon JE, Robertson AHF (eds) The Geological Evolution of the Eastern Mediterranean, Geol Soc London, Spec Publ 17:1–74.
23. Yılmaz, Y., Gürpınar, O., Kozlu, H., Gül, M. A., Yiğitbaş, E., Yıldırım, M., Genç, C., & Keskin, M. (1987). Maraş kuzeyinin jeolojisi (Andırın- Berit-Engizek-Nurhak-Binboğa Dağları) yapı ve jeolojik evrimi. İstanbul Üniversitesi, Mühendislik Fakültesi.
24. De Righi, M. R., & Cortesini, A. (1964). Gravity tectonics in foothills structure belt of southeast Turkey. *AAPG Bulletin*, *48*(12), 1911-1937.
25. Gül, M. A. (2000). Kahramanmaraş Yöresinin Jeolojisi. Hacettepe Üniversitesi, Fen Bilimleri Enstitüsü, Doktora Tezi, 304 s.
26. Gözübol, A. M. & Gürpınar, O. (1980). Kahramanmaraş Kuzeyinin Jeolojisi ve Tektonik Evrimi. Türkiye 5. Petrol Kong., Jeoloji-Jeofizik Bild., s. 21-29, Ankara.
27. Gül, M.A. (1987). Kahramanmaraş Yöresinin Jeolojisi ve Petrol Olanakları. T.P.A.O. Rap. No: 2359, (Yayınlanmamış), Ankara.
28. Yılmaz, Y. & Yiğitbaş, E. (1990). SE Anadolu'nun Farklı Ofiyolitik Metamorfik Birlikleri ve Bunların Jeolojik Evrimdeki Rolü Türkiye 8. Petrol Kong. Bild. s. 128-140, Ankara.
29. Blumenthal, M. M. (1947). Geologie der Taurusketten im Hinterland von Seydişehir und Beyşehir, M. T. A., Ankara.
30. Dean, W. T., & Monod, O. (1990). Revised stratigraphy and relationships of Lower Palaeozoic rocks, eastern Taurus Mountains, south central Turkey. *Geological Magazine*, *127*(4), 333-347.
31. Yoldemir, O. (1987). Suvarlı-Haydarlı-Narlı-Gaziantep Arasında Kalan Alanın Jeolojisi ve Petrol Olanakları. T.P.A.O. Rap. No: 2275, Ankara (yayınlanmamış).
32. Ulu, U., Genç. Ş., Giray, S., Metin, Y., Çörekçioğlu, E., Örçen, S., Ercan, T., Yaşar, T. & Karabıyıkoğlu, M., (1991). Belveren-Araban-Yavuzeli-Nizip-Birecik Alanının Jeolojisi, Senozoyik Yaşlı Volkanik Kayaçların Petrolojisi ve Bölgesel Yayılımı. M.T.A. Enst. Derleme Rap. No: 9226 (Yayınlanmamış), Ankara.
33. Robertson, A. H. F. & Dixon, J. E. (1984). Introduction: aspects of the geological evolution of the Eastern Mediterranean. In: Dixon JE, Robertson AHF (eds) The Geological Evolution of the Eastern Mediterranean, Geol Soc London, Spec Publ, 17:1–74.
34. Yılmaz, Y. (1993). New evidence and model on the evolution of the southeast Anatolian orogen. *Geological Society of America Bulletin*, 105:251–271.
35. Yılmaz, Y., Gürpınar, O., Kozlu, H., Gül, M. A., Yiğitbaş, E., Yıldırım, M., Genç, C. & Keskin, M. (1987). Maraş kuzeyinin jeolojisi (Andırın- Berit-Engizek-Nurhak-Binboğa Dağları) yapı ve jeolojik evrimi. İstanbul Üniversitesi, Mühendislik Fakültesi.
36. Yılmaz, Y., Yiğitbaş, E., Gürpınar, O. & Yiğitbaş, E. (1988). Amanos Dağları ve Maraş Dolaylarında Miyosen Havzalarının Tektonik Evrimi. T.P.A.O. Bülteni C.1/1, 52-72.
37. Yiğitbaş, E. (1989). Engizek dağı (K.Maraş) dolayındaki tektonik birliklerin petrolojik incelenmesi; Doktora tezi, İstanbul Üniversitesi. Fen. Bilimleri Enstitüsü, 347 s.

38. Robertson, A. H. F., Ünlügenç, U. C., İnan, N. & Taslı, K. (2004). The Misis–Andırın Complex: a Mid Tertiary mélange related to late-stage subduction of the Southern Neotethys in S Turkey. Journal of Asian Earth Sciences, 22:413–453.
39. Herece, E. (2008). Atlas of East Anatolian Fault, General Directorate of Mineral Research and Exploration, Special Publication Series-13, 359, 13 appendices as separate maps. ISBN / ISSN: 9786054075126.
40. Clark, S. H. B., Poole, F. G., & Wang, Z. (2004). Comparison of some sediment-hosted stratiform barite deposits in China, the United States, and India. Ore Geology Reviews, 24, 85–101.
41. Jewell, P. W. (1994). Paleoredox conditions and the origin of bedded barites along the Late Devonian North American continental margin. The Journal of Geology, 102, 151–164.
42. Jewell, P. W., & Stallard, R. F. (1991). Geochemistry and paleoceanographic setting of central Nevada bedded barites. Journal of Geology, 99, 151–170.
43. Torres, M. E., Brumsack, H. J., Bohrman, G., Emeis, K. C. (1996). Barite fronts in continental margin sediments: a new look at barium remobilization in the zone of sulphate reduction and formation of heavy barites in diagenetic fronts. Chemical Geology, 127, 125–139.
44. Binns, R. A., Parr, J. M., Gemmell, J. B., Whitford, D. J., & Dean, J. A. (1997). Precious metals in barite-silica chimneys from Franklin Seamount, Woodlark Basin, Papua New Guinea. Marine Geology 142, 119–141.
45. Leach, D. L., Bradley, D. C., Huston, D., Pisarevsky, S. A., Taylor, R. D., & Gardoll, S. J. (2010). Sediment-hosted lead-zinc deposits in Earth history. Economic Geology, 105, 593–625.
46. Sverjensky, D. A. (1986). Genesis of Mississippi Valley-type lead-zinc deposits. Annual Review of Earth and Planetary Sciences, 14, 177–199.
47. Ravenhurst, C. E., Reynolds, P. H., Zentilli, M., Kreuger, H. W., & Blenkinsop, J. (1989). Formation of Carboniferous Pb-Zn and barite mineralisation from basin-derived fluids, Nova Scotia, Canada. Economic Geology, 84, 1471–1488.
48. Williams-Jones, A. E., Schrijver, K., Doig, R., & Sangster, D. F. (1992). A model for epigenetic BaPb-Zn mineralization in the Appalachian thrust belt, Quebec: evidence from fluid inclusions and isotopes. Economic Geology, 87, 154–174.
49. Özdoğan, A. T., Uras, Y. & Öner, F. (2017). Geochemistry of the barite deposits near Adana-Feke area (Eastern Taurides). Russian Geology and Geophysics, 58, 1351–1367.
50. Yalçın, C. (2022). Preliminary Datas of Carbonate-rock hosted barite Mineralization in Dadağlı (Kahramanmaraş) area, Turkey. *Advanced Engineering Days (AED)*, *2*, 33-35.