Geochemistry of the Tajo granite, Socorro County, New Mexico

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Abstract

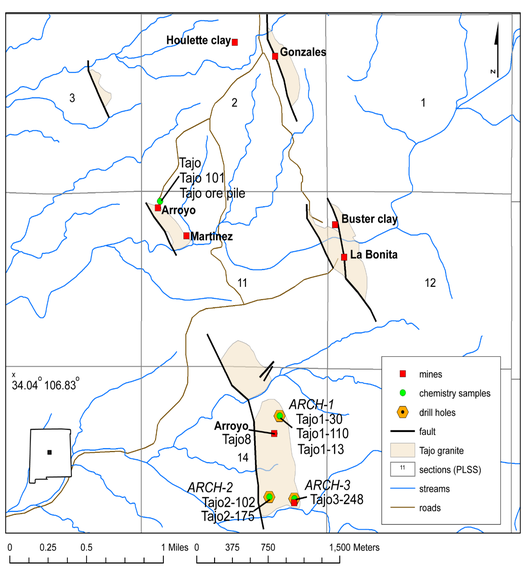
The Proterozoic Tajo granite consists of six outcrops along two northwest-striking faults east of Socorro, New Mexico. The area was originally examined for uranium, but fluorite and rare earth elements (REE) are reported as well (Fieldman, 1977). REE consist of the 15 lanthanide elements, including scandium and yttrium, and are fundamental to modern society. Although common in the crust, REEs are not often in economically viable concentrations. Some Proterozoic granites in New Mexico, including the Tajo granite, contain uranium and REE, but their economic resource potential is unknown. We conducted a petrographic and geochemical study of the Tajo granite to determine its mineral resource potential. The Tajo granite is medium-to coarse-grained, peraluminous, A-type granite. Geochemical comparisons of the Tajo granite to other Proterozoic granites found in central New Mexico including the Gallinas and Los Pinos Mountains show that Tajo has an unusual composition. It is enriched in Rb, U and Th compared to most Proterozoic granites, and depleted in CaO, Na_2O, and Sr. The Tajo granite is low in U, Nb, and REE, and does not have any economic potential.

Introduction

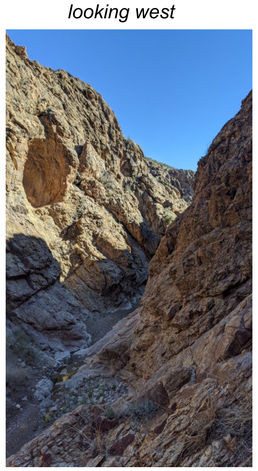
Rare earth elements (REE) consist of the 15 lanthanide elements, scandium, and yttrium, and are fundamental to a wide variety of technologies including electric cars, energy efficient lights, and smart devices (Long et al., 2010). REE are common in the crust, but do not occur in economic concentrations. Because of American's heavy reliance on other countries for REE supplies, identifying, analyzing, and categorizing potential REE deposits could serve as a considerable independent, economic, and strategic interest. Proterozoic granites in New Mexico (Zelenka, 1984; McLemore and North, 1988; McLemore, 2014), including the Tajo granite, could serve as potential mineral resources for REE if their concentrations are sufficiently high.

In the late 1970s, the Rocky Mountain Energy Company drilled for uranium at the Tajo granite east of Socorro, New Mexico (drill core archived at the NMBGMR core library). The deposit was compared to the granite-hosted Rossing deposit in Nambia (Basson and Greenway, 2004) and to the Alaskan Bokan Mountains (Dostal and others, 2014), both of which contain important resources of U, Th, and REE in granitic rocks. The purpose of this study is to characterize the Tajo granite (mineralogy and geochemistry), compare it to other similarly-aged granites in New Mexico, and to assess Tajo's economic mineral-resource potential.

Figure 1. Geologic map of the Tajo granite showing locations of high gamma radiation, modified from McLemore (1983) and Cather and Colpitts (2005).



Arroyo del Tajo looking west



Methods

- Logged drill core noting mineralogy, color, and alteration
- Prepared and sent samples for XRD, geochemistry, and thin section
- Created various plots to explain the geochemical characteristics
- Analyzed the thin sections noting mineralogical abundances, features, and alteration
- Compared Tajo to similarly-aged granites of the Gallinas and Los Pinos Mountains

From left to right: Individual piece of core displaying a green mineral thought to be uranophane, a complete box of wet core. Purple fluorite vein cross-cutting and offsetting a pink-orange barite vein

Figure 2. X-ray diffraction pattern of an unaltered piece of core with muscovite with microline and quartz

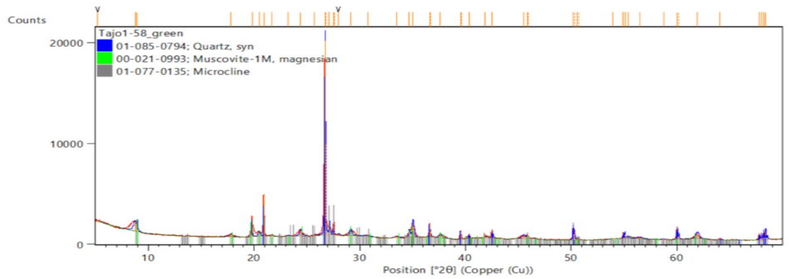


Figure 6. QAP diagram classifying Tajo using modal abundances from thin section analysis

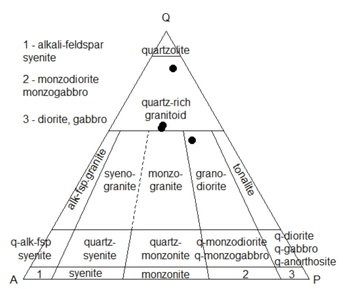


Figure 3. CaO-Na2O-K2O ternary diagram comparing Proterozoic Tajo, Gallinas, Sevilleta, and Los Pinos granite to the geochemical groups established by Condie (1978).

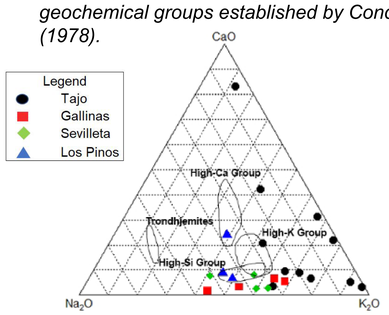


Figure 4. Select Nb and (Na2O+K2O)/CaO vs Ga/Al plots from Whalen (1987) used to distinguish A-type granites from I- and S-type granites including Proterozoic Tajo, Gallinas, and Sevilleta granite samples.

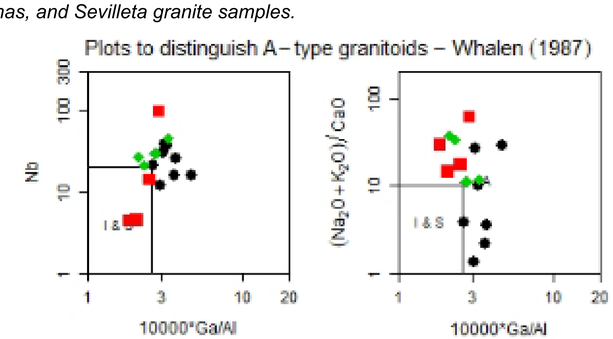
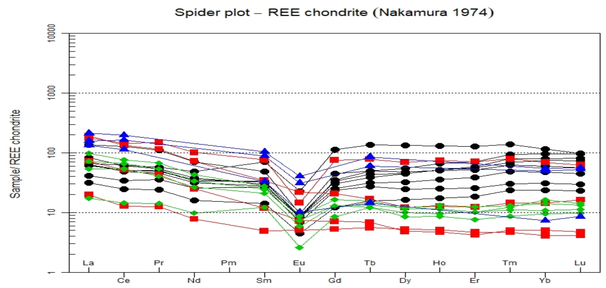


Table 1. Table depicting the Rb, Th, and U values for each sample and the average from Condie (1971)

	Rb (ppm)	Th (ppm)	U (ppm)	Total REE		Rb (ppm)	Th (ppm)	U (ppm)	Total REE
Tajo	391	35.3	182	285.51	Gal97 (McLemore et al., 2021)	254	20.9	4.53	370.2
Tajo 101	181	16.95	262	281.68	Gal56 (McLemore et al., 2021)	167	4.4	0.89	31.39
Tajo1-30	455	21.6	20.1	181.91	Gal245avg (McLemore et al., 2021)	122.5	39.85	8.635	264.5
Tajo1-13	353	18.65	24.5	163.48	Gal246 (McLemore et al., 2021)	236	29.9	2.41	98.63
Tajo1-110	391	23.1	21.3	176.85	Average	194.9	23.8	4.1	191.2
Tajo2-102	181	9.2	8.024	69.55	SEV-5 (McLemore, 2016)	283	23.9	2.26	105.5
Tajo2-175	455	21.4	9.45	138.51	SEV-6 (McLemore, 2016)	306	8.73	4.22	42.42
Tajo3-248	353	11.25	5.43	102.07	SEV 14 (McLemore, 2016)	356	18.45	3.1	154.9
Tajo12 (McLemore, 1983)	433	21	42	NA	SEV 15 (McLemore, 2016)	307	19.65	1.95	125.6
Tajo8 (McLemore, 1983)	390	29	17	NA	Average	313	17.7	2.9	107.1
Tajo ore pile (McLemore, 1983)	340	46	161	NA	High-Ca group (Condie, 1979)	173	14	3.7	148.7
Average	356.6	23	68.4	174.9	High-Si group (Condie, 1979)	167	18	5	182.1
Priest (Condie and Budding, 1979)	191	NA	NA	152.05	High-K group (Condie, 1979)	272	14	4	253.2
Los Pinos (Condie and Budding, 1979)	135	NA	NA	282	Average	204	15.3	4.2	194.7
Sepultura (Condie and Budding, 1979)	223	NA	NA	229					
Average	183	NA	NA	221					

Figure 6. Chondrite-normalized REE plot (Nakumara, 1974) comparing Proterozoic Tajo, Gallinas, Sevilleta granite, and Los Pinos granite.



Conclusion

- Tajo granite is classified as a granitoid to granodiorite with elevated levels of Th, Rb, and U
- The granite is peraluminous, magnesian, and A-type
- Tajo granite is unusual in composition when compared to other New Mexican Proterozoic granite plutons, and is similar in REE than other granites
- Depleted REE and low elevated levels of Th and U make Tajo an uneconomic source at this time
- Future studies would need to characterize the processes that depleted the REE

Acknowledgements

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