

Research Advances

Adakitic Rocks Resulting from Partial Melting of Metabasite at High-Pressure Granulite-Facies Condition during Continental Collision

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Objective

Previous studies on adakitic rocks with high Sr/Y and La/Yb ratios have established that such rocks may form in a variety of tectonic settings through different petrogenetic processes including: (1) partial melting of subducted young (<25 Ma), hot and hydrated oceanic slab; (2) partial melting of thickened lower crust; (3) assimilation and fractional crystallization processes involving basaltic magma; (4) partial melting of delaminated lower crust; and (5) partial melting of hydrous garnet peridotite. The various origins for adakites provide important constraints on crustal growth and evolution throughout the Earth's history. Previous research on the genesis of adakitic rocks has largely come to be understood through a combination of studies on the geochemistry of granitoids and experimental studies on the partial melting of mafic rocks. However, direct evidence for generating adakitic rocks on the microscopic to field scales is lacking. The North Qaidam Mountains of western China is ideally suited to study adakitic rocks formation because primary anatectic texture and compositions are well preserved.

Methods

In combination of structural geology, petrology, mineralogy and geochemistry, this project focuses on the study of high-pressure (HP) granulites and related anatectic adakitic rocks in the Dulan eclogite-gneiss unit, the North Qaidam Mountains, which will clarify: (1) the range and distribution characteristic of high-pressure granulite and adakitic rock and their relationship; (2) the reaction type and microstructure character of partial melting, related to the formation of adakitic rock in

thickened lower crust; (3) the fractionation, enrichment, migration and redistribution of trace element during anatexis; (4) the relationship and mechanism between high-pressure and adakitic rock. On the basis of above-mentioned research, this project will finally provide field petrology, petrography and matched geochemical evidence for study of adakitic rocks in continental circumstances, and migration and redistribution of trace element during anatexis; and which will also play a significant role in the study of the formation, fractionation, evolution and related deep dynamics process of continental crust.

Results

On the basis of large-scale mapping, a high-pressure granulite unit has been recognized in the Dulan area of the North Qaidam ultrahigh-pressure (UHP) metamorphic terrane, which is predominately composed of mafic HP granulite with minor felsic HP granulite, paragneiss, orthogneiss and amphibolite. Both macroscopic and microscopic observations provide strong evidence of in-situ partial melting for metabasite with adakitic melt and HP mafic granulite residuum. Migmatite shows successive stages of initial miniscale intragranular or droplet-like melt along grain boundaries, which grow into a three-dimensional interconnected intergranular network, segregate and accumulate in pressure shadow areas, and merge to form melt channels and sheets that finally combine to form adakitic tonalite pluton. Based on zircon U-Pb dating and petrological analyses, partial melting occurred 438–430 Myr ago, which temporally overlapped with the UHP metamorphism at 440–425 Myr ago. The felsic leucosomes and tonalite plutons are characterized by high Sr, Sr/Y and La/Yb and low HREE, with $\epsilon_{\text{Nd}}(t)$ values of -0.4 – 4.8 , similar to typical adakitic rocks.

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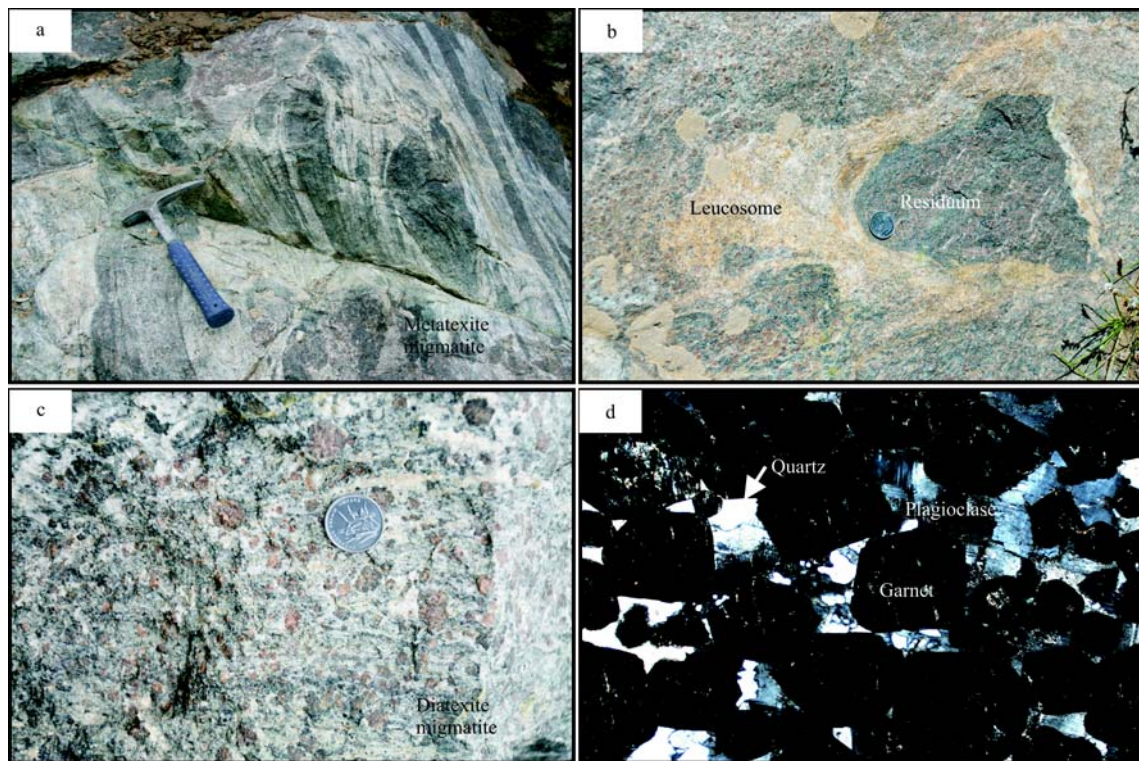


Fig. 1. Field and microphotographs showing the textures of in-situ partial melting.

Conclusion

An integrated study of the petrology, geochronology and geochemistry demonstrates that adakitic rocks can be derived from the partial melting of newly emplaced metagabbro under HP granulite-facies conditions in thickened lower crust during continental collision. Penecontemporaneous metamorphic ages but different geothermal gradients between HP granulites and related

UHP eclogite define a possible paired metamorphic belt generated in a subduction–collision setting.

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