Research Advances

Petrogenesis of the Shadegai Pluton in Inner Mongolia: Evidence from Petrography, Element Geochemistry and Geochronology

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Objective

The widely exposed granites in the Wulashan area of Inner Mongolia are an important component of intermediate-acidic magma belt at the northern margin of the North China Craton, and are also a natural laboratory to research the origin of granite bodies. The Shadegai pluton, a representative intrusion, intruded into the Wulashan Group metamorphic rocks, occurring as stock, and was controlled by the Linhe-Jining deep fracture. This pluton is composed of dominant K-feldspar granites and less biotite moyite, with abundant mafic microgranular enclaves (MMEs) dominated by gray black monzonite. Most MMEs have a sharp contact zone with their host granite, and few have a gradual contact relationship. Previous researches have described the characteristics of petrology and chronology of the Shadegai pluton, but few have focused on the characteristics of the petrography, element geochemistry and isotope chronology of the host granite, its widely developed MMEs and the magmatism process. This work systematically analyzed the Shadegai granitic pluton and its MMEs, including the characteristics of their petrography, element geochemistry and chronology, in order to discuss the petrogenesis.

Methods

Samples were collected from the Shadegai strip pit. All MMEs and their host granite are representative fresh samples. Petrographic characteristics were observed under a binocular microscope. The electron probe microanalysis (EPMA) of plagioclase, potassium feldspar, biotite and hornblende were conducted at the EPMA Room, Academy of Science, China University of Geosciences (Beijing). Major and trace element compositions and zircon U-Pb geochronology were all carried out at the Ore Deposit Geochemistry Microanalysis Room, the State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences (Beijing). Major element determinations were by X-ray fluorescence spectroscopy. Trace element abundances were determined by inductively-coupled plasma mass spectrometry (ICP-MS). U-Pb isotope analyses were carried out using a laser ablation inductively coupled mass spectrometer (LA-ICP-MS).

Results

Petrographic observation shows that the MMEs have either a sharp or a gradual contact zone with their host granite and the MMEs contain various typical textures, whose origin can be explained in terms of magma mixing and mingling, including quartz ocelli, rapakivi feldspars, mafic clots, resorption of K-feldspar megacrystals, acicular apatite morphology, inclusion zones in feldspars, and anorthite “spikes” in plagioclase (Fig. 1). Some MMEs occur as lentoid, long striped, or embay, indicative of different rheological properties of the contrasting magmas. Major element concentrations of the MMEs and their host granite and plagioclase show obvious linear relation with the SiO_2 content, indicating the importance of the magma mixing and mingling in the formation of the Shadegai pluton. Chemical component of the total rock and biotite and hornblende show mixed characteristics of mantle-crust magmas. The host granite magma may be derived from the lower crust, while magma for the MMEs originated from the mantle. LA-ICP-MS isotopic dating on zircons from the granite and its MMEs obtained similar ages of 233.4±2.3 Ma and 229.1±1.7 Ma, respectively, further indicating the existence of magma mixing and mingling during their genesis.

Conclusions

The characteristics of petrology, element geochemistry and isotope chronology show that the Shadegai granite and its MMEs are the products of magma mixing and

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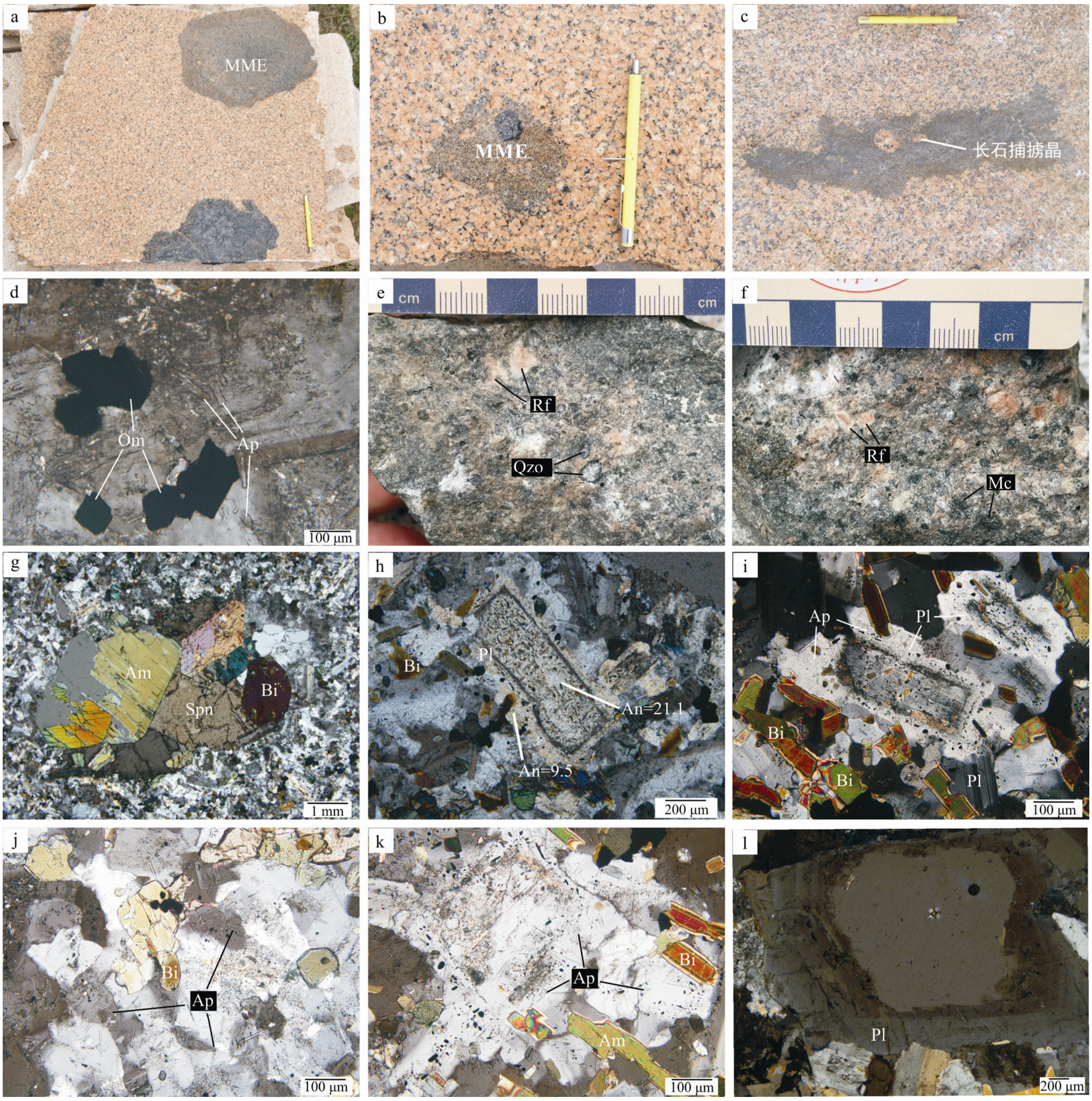

Fig. 1. Field photos and micrographs of the Shadegai granite and its MMEs.
(a), Monzonite enclaves in moyite, which have a sharp contact zone with their host granite; (b), Monzonite enclaves in moyite, which have a gradual contact zone with their host granite; (c), Irregular contact zone between MMEs and their host granite; (d), Stumpy apatite morphology and opaque minerals (+); (e), Quartz ocelli and rapakivi feldspars; (f), Rapakivi feldspars and mafic clots in MMEs; (g), Mafic clots consisting of biotite, sphene and amphibole(+); (h), Anorthite spikes (+); (i), Fine grain mafic minerals enveloped in the enclave belt of plagioclase with many acicular apatite(+); (j, k), Speculate and acicular apatite(+); (l), Compositional zoning of plagioclase(+). MME, Mafic microgranular enclaves; Om, Opaque mineral; Rf, Ring spot feldspar; Qzo, Quartz ocelli; Mc, Mafic clot; Am, Amphibole; Spn, Sphene; Bi, Biotite; Pl, Plagioclase; An, Anorthite; Ap, Apatite; (+), Crossed polarizing filters.

mingling, which represents the felsic magma is derived from the lower crust and the femic magma is originated from the mantle. During the mixing process, the exchange of materials has taken place.

Acknowledgements

This research was funded by the National Natural Science Foundation of China (grant No. 41302064).