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The Cenozoic Basalts From Simao Microcontinent, Eastern Tibet Plateau: The Geochemical Characteristics and Tectonic Significance

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1 Geological Background

The Cenozoic basalts in Simao microcontinent mainly distribute in Puer and Tongguan area and extend in NW or NS direction constraining by the structure. There is an angular unconformity between the basalts and overlying Cretaceous strata. The K-Ar chronology study carried out by Sun *et al.* (2000) report an age of 1.14~1.21Ma, show that these basalts formed in Pleistocene. Without any alteration, the rock is really fresh and the rock types including alkali-olivine basalt and vesicular basalt are sample. Through analysis under microscope, the main mineral composition of these rocks is pyroxene and olivine (both <5%). With a cryptocrystalline matrix, the rocks show porphyritic texture, massive structure or vesicular structure.

2 Geochemical Characteristics

The geochemical characteristics of these rocks are uniform. The major elements, such as SiO₂ (45.34~50.39 wt.%), TiO₂ (2.10~2.23 wt.%), MgO (5.36~6.69 wt.%), K₂O (1.86~3.09 wt.%) and so on, show that the rocks are alkali basalt, belonging to shoshonite series. The trace elements are characterized as intensely enriched in large ion lithophile element (LILE) and incompatible elements, such as Nb, Ta, Zr and Hf. All the samples showed similar chondrite-normalized rare earth elements patterns (REE), with varying light REE enrichment [(La/Yb)_N=5.72~8.48] and unobvious positive Eu anomalies. These geochemical feature is extremely similar with the Cenozoic basalts in Maguan and Pingbian (Wang *et al.*,

2001; Xia and Xu, 2004; Wei *et al.*, 2006), which indicate that they may have the same source region. The low 87Sr/86Sr (0.70343~0.70381), 143Nd/144Nd (0.51293~0.51298) and positive εNd (t) (5.5~4.7) show affinitive isotopic characteristics with depleted mantle.

3 Source Characteristics

The pattern of rare elements, Ti/V, Nb/Th and La/Nb ratios and the Sr-Nd isotopic data show that the OIB-type characteristics exert a strong control on the trace element systematics of the these basalts. However, unlike the OIB-type basalts in ocean island environment, the OIB-type basalts in continental environment are usually originated from asthenosphere- lithosphere interaction, such as Emeishan basalts (Xu *et al.*, 2001). It is worth noting that the Sr-Nd isotopic data show inconsistent information with the trace elemental data which reflect an enriched source region characterized as high light REE, LILE and high field-strength element (HFSE). A reliable model summed up from the research of Mesozoic-Cenozoic basalts in eastern China can be introduced to interpret the geochemical characteristics of basalts in this paper: the magma originated from the metasomatic lithospheric mantle which is enriched by the fluids/melt derived from the asthenosphere. There is not enough time to transfer the “enrichment information” to isotopic composition through the decay of radioactive isotopes, and that’s why the Sr-Nd isotopic data are still depleted.

The Cenozoic basalts in Simao microcontinent are mainly shoshonite with high content of K. So, it is necessary to discuss the source of K. There are several possible interpretation which could be considered for the

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petrogenesis of the potassic rocks: 1, the mantle-derived magmas intensely contaminated by crustal material (Harris, 1957); 2, high-degree fractional crystallization of the magma which is partial melting by garnet lherzolites (Kay and Gast, 1973); 3, originated from lithospheric mantle metasomatic by subduction-related fluids/melt (Menzies *et al.*, 1987); 4, partial melting by the lithospheric mantle enriched in phlogopite or amphibole (Turner *et al.*, 1996). The crustal contamination can be excluded by the OIB-like trace elemental characteristics, the low $^{87}\text{Sr}/^{86}\text{Sr}$ and high $\epsilon_{\text{Nd}}(t)$ values, the positive anomaly of FHSE and the ratios of incompatible elements, such as Th/Ta, La/Nb and Nb/Th. There is no obvious evidence for the high-degree fractional crystallization of the magma, as considering of the Hark diagram and La versus La/Sm diagram (figure not shown). Previous studies on potassic rocks in "Sanjiang area" show that the K-rich rocks originated from lithospheric mantle metasomatic by subduction-related fluids/melt usually show obvious depletion in Nb, Ta and Ti. So, the most appropriate interpretation to the origin of K-rich rocks in study area is partial melting of lithospheric mantle which is enriched in phlogopite or amphibole.

Based on the analyses above, we can draw conclusions that the Cenozoic basalts in Simao microcontinent formed by the partial melting of phlogopite/amphibole-bearing lithospheric mantle which is enriched by the fluids/melt derived from the asthenosphere.

4 Tectonic Significances

Previous studies showed Cenozoic activities in the eastern Indo-Asian collision zone of southeast China occurred in two periods, each with distinctive geochemical signatures, at 42–24 Ma and 16–0 Ma (Wang *et al.*, 2001). In consideration of the chronology and the geochemical characteristics, this paper suggests that the Cenozoic basalts in Simao microcontinent are belong to the later period magmatism of Cenozoic activities.

Note that the later period magmatism including basalts from Maguan, Pingbian, Tongguan and Puer have many commonalities besides the forming age, such as the mechanism of source enrichment, small area of outcrop, located on both sides of Ailaoshan-Red River fault zone. Based on these analyses, it is reasonable to connect the formation mechanism of these rocks with the Indo-Asian collision. Mo *et al.* (2006) presented that Neo-Tethyan asthenospheric mantle was laterally displaced along discrete northeast and southwestward flow channels in

response to the India-Asia collision. Based on this model, we conclude that the fluid/melt from asthenospheric mantle horizontally migrate as the form of small-scale upwelling or extrusion, then modified the lithospheric mantle forming K-rich material. Low-degree partial melting of metasomatic lithospheric mantle formed the small-scale Cenozoic dispersedly distributed along Simao microcontinent and Ailaoshan-Red River fault zone.

In summary, the Cenozoic basalts from Simao microcontinent, with the similar geochemical characteristics with the basalts of Mguan and Pingbian area, are the record of the flow and migration of asthenospheric mantle along the Simao microcontinent and Redriver-Ailaoshan fault zone.

References

- Harris P.G., 1957. Zone refining and the origin of potassic basalts. *Geochimica et Cosmochimica Acta*, 12: 195-208
- Kay R.W., Gast P.W., 1973. The rare earth content and origin of alkali-rich basalts. *The Journal of Geology*, 81: 653-682
- Menzies M.A., Rogers N.W., Tindle A., 1987. Metasomatic and enrichment processes in the Earth's mantle. In: Menzies M A, Hawkesworth C J, eds. *Mantle Metasomatism*. London: Academic Press, 1-472
- Mo X.X., Zhao Z.D., Deng J.F. et al., 2006. Petrology and geochemistry of postcollisional volcanic rocks from the Tibetan plateau: implications for lithosphere heterogeneity and collision-induced asthenospheric mantle flow. In: Dilek, Y., Pavlides, S. (Eds.), *Postcollisional tectonics and magmatism in the Mediterranean region and Asia*. *Geol. Soc. Am. Spec. Pap.*, 409:507–530
- Sun H.J., 2000. The Cenozoic potassic magmatism in eastern Tibet and Southeast Yunnan Province. Ph. D. Dissertation. Beijing: *Institute of Geology and Geophysics, Chinese Academy of Sciences*, 29-61(in Chinese with English Abstract)
- Turner S., Arnaud N., Liu J., et al., 1996. Post-collision, shoshonitic volcanism on the Tibetan Plateau: Implications for convective thinning of the lithosphere and the source of ocean island basalts. *Journal of Petrology*, 37 (1): 45-71
- Wang J.H., Yin A., Harrison T.M., et al., 2001. A tectonic model for Cenozoic igneous activities in the eastern Indo-Asian collision zone. *Earth and Planetary Science Letters*, 188: 123-133
- Wei Q.R., and Wang J.H., 2004. Geochemical characteristics of Cenozoic basalt high-K volcanic rocks form Maguan Area, Eastern Tibet. *Chinese Journal of Geochemistry*, 23(1):57-64
- Xia P., and Xu Y.G., 2004. Lithosphere mantle domain discrimination and enrichment mechanism in west Yunnan: a study on the contrast of two types of Cenozoic ultra-potassic volcanic rocks. *Sci China(D)*, 34(12): 1118-1128(in Chinese).
- Xu Y.G., Chung S.L., Jahn B.M., et al., 2001. Petrologic and geochemical constraints on the petrogenesis of Permian–Triassic Emeishan flood basalts in southwestern China. *Lithos*, 58 (3-4): 145-168