

## A composite M- with W-type of REE tetrad effect in a North China alkaline complex

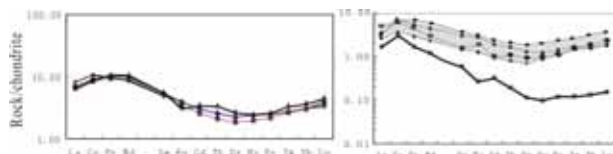
ZHENHUA ZHAO<sup>1</sup>\*, Z. BAO<sup>1</sup>, S.-G. LEE<sup>2</sup> AND Y. QIAO<sup>1</sup>

<sup>1</sup>Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou 510640, China

(\*correspondence: zhzhao@gig.ac.cn)

<sup>2</sup>Environmental Geology Division, Kigam, Daejeon, Korea

A new type of REE tetrad effect, an MW-type, was recognized in the Dongping altered alkaline complex, north China. Systematic studies have revealed that the chondrite-normalized REE patterns of these rocks are different from the M- and W-type of tetrad effects defined by Masuda *et al.* (1987) and combine characteristics of the two types. The first four elements (La, Ce, Pr, Nd) exhibit a clear convex curve (M-type) while the third and fourth sets of four elements (Gd, Tb, Dy, Ho and Er, Tm, Yb, Lu) define two distinct concave curves (W-type) on chondrite-normalized plots. The second four elements (Pm, Sm, Eu, Gb) show a transition from M- to W-type (Fig.1).



**Figure 1:** Chondrite normalized REE pattern of alkaline rocks.

Different analytical methods such as ICP-MS and isotope dilution thermal ion mass spectrometer were carried out in three laboratories in China, France and Korea to confirm the REE concentrations of the samples. The same results were obtained within reliable errors. *In situ* analysis of U-Pb dates and REE concentrations in 30 individual zircons extracted from the same altered rocks has provided evidence about the generation of this new MW-type of tetrad effect. Their isotopic ages show a continuous age spectrum from 394 Ma to 217 Ma with mean age 389.8 Ma. The chondrite-normalized REE patterns of most zircons display features typical of hydrothermal zircons, including weak positive Ce anomalies and relatively low enrichments of HREE. These data suggest that the new MW-type of tetrad effect is likely to be caused mainly by the interaction of aqueous liquids with alkaline rocks.

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## Nature of the subcontinental mantle beneath southern Tibet revealed by mantle xenoliths entrained by ultrapotassic rocks

ZHIDAN ZHAO<sup>1</sup>\*, X. MO<sup>1</sup>, Y. NIU<sup>2</sup>, D. ZHU<sup>1</sup>, C. SUN<sup>1</sup>, G. DONG<sup>1</sup> AND S. ZHOU<sup>1</sup>

<sup>1</sup>State Key Laboratory of Geological Processes and Mineral Resources, and School of Earth Sci & Mineral Resources, China University of Geosciences, Beijing 100083, China (\*correspondence: zd-zhao@163.com)

<sup>2</sup>Department of Earth Sciences, Durham University, Durham DH1 3LE, UK (Yaoling.Niu@durham.ac.uk)

The nature of the subcontinental mantle of Tibetan Plateau is not well-known, although lots of postcollisional volcanic rocks in Tibet have been inferred to be generated by low degrees of partial melting from the upper mantle. The key problem is that mantle-derived xenoliths and megacrysts hosted in potassic and ultrapotassic volcanic rocks are rarely found in the hinterland of Tibetan plateau. Here we firstly report our major and LA-ICP-MS trace element data of the minerals of the mantle xenoliths hosted in the Sailipu volcanic rocks (trachyandesite, with an age of ~17 Ma, have typical ultrapotassic features that similar to that found in southern Tibet). The xenoliths, ranging in size from 0.5cm to 1.5cm in diameter, can be divided into two groups. The first group is pyroxenites (Opx+Cpx), and the second is olivine pyroxenites (Ol+Opx+Cpx±Phlogopite±Spinel). The compositions of olivine (Mg#=89-90, CaO=0.05-0.12%, TiO<sub>2</sub><0.03%, NiO=0.29-0.80%), Cpx (Mg#=88-91, Al<sub>2</sub>O<sub>3</sub>= 5.5-7%), Opx (TiO<sub>2</sub>=0.05-0.15%, Al<sub>2</sub>O<sub>3</sub>=2-5%) and spinel (Mg#=58-76, Cr#=10-44, Cr<sub>2</sub>O<sub>3</sub>=9-35%, MnO=0.09-0.24%, FeO=11-18%, Al<sub>2</sub>O<sub>3</sub>=29-57%, MgO=16-21%) show similar features to that in the Cenozoic mantle xenolith in eastern China. The calculated temperatures of the xenolith are 990-1140°C at the given pressures of ~1.6-2.0GPa. This P-T condition is similar to that in Kenya and other rift-related upper mantle regimes, implying the regional extension beneath southern Tibet in Miocene, although India were colliding with Asia during that time. Multi-stage metasomatic processes could be found by the trace element compositions in phlogopite, cpx and spinel. Both Cpx and phlogopite are rich in LREE, Th and U (phlogopite extremely rich in Rb and Pb). The secondary spinel along with neighboring phlogopite suggest that a ultrapotassic, host-rock like metasomatic agent that enriched in REE, Rb, Pb, Th, U, K, H<sub>2</sub>O, should have played an important role in modifying the upper mantle beneath southern Tibet.