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Lithospheric origin of the DUPAL anomaly: A case study of a suite of Miocene basalts across the Siberian craton boundary

E. Demonterova (1), A. Ivanov (1), and V. Savatenkov (2)

(1) Institute of the Earth's crust SB RAS, Irkutsk, Russian Federation (dem@crust.irk.ru), (2) Institute of Precambrian Geology and Geochronology RAS, St-Petersburg, Russian Federation

DUPAL is a lead isotope anomaly in basalts which has been long considered to be a unique feature of the Southern Hemisphere. Originally it was preferentially explained as a very ancient anomaly located deep in the lower mantle and sampled by plumes. However, recent studies have reinterpreted, at least the DUPAL signature in Indian Ocean basalts, as recycled lower crust. Basalts with DUPAL isotopic features are also known in the Northern Hemisphere at a few places. In the East Sayan range, Siberia, Miocene basalts with DUPAL-like signatures have been reported from the Riphean Tuva-Mongolian massif, whereas basalts outside this massif are non-DUPAL. In the present work we sampled Miocene (15-17 Ma) basalts along a 70-km long profile which runs from the Tuva-Mongolian massif to the Siberian craton. The structural boundary between these two lithospheric blocks is sharp and indisputable. It is accommodated by the kilometer-wide Major Sayan Fault. There are minor differences in major and trace elements between the Miocene basalts emplaced within the craton and within the Tuva-Mongolian massif, namely, the former have lower TiO2, lower LREE/HREE ratios and higher Al2O3. The most striking difference is seen in the Delta-8/4 lead isotope ratios. These ratios are typically DUPAL-like in the cratonic basalts, lying in the range 62-75. In basalt erupted within the Tuva-Mongolian massif the ratio is lower (55-62) but still elevated compared with basalts erupted outside the massif. The cratonic basalts are also characterized by lower 143Nd/144Nd ratios and a narrower 87Sr/86Sr ratio range compared to off-cratonic basalts. We find that the lead isotope signature in Miocene basalts of the East Sayan range is strongly dependent on lithospheric structure and we conclude that the DUPAL signature is lithospheric in origin. This work was supported by RFBR (grant 08-05-98100) and the President of the Russian Federation (grant MK-1228.2008.5).