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Timing Constraint on Multiple Events of Subcontinental Lithosphere: Inferred from SHRIMP U/Pb Ages of Lower Crust Xenoliths, North China Craton

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Isotopic dating of lower crust al xenoliths from a few localities in the world provided diverse age data which can be correlated with the regional geological events. This has been interpreted as geodynamic processes affecting both the deep and shallow levels of the crust, and therefore tectonic coupling between rocks from deep level and those on surface has been emphasized (cf. Rudnick and Williams, 1987; Rudnick and Cameron, 1991; Chen et al., 1994; Davies, 1997). The above results are restricted to post-Archean areas; only one such study was carried out for xenoliths from Archean cratons, i.e. the Slave Province of Canadian Shield, but no age diversity was observed (Davies, 1997). Questions are raised whether diverse age patterns are only restricted to post-Archean areas, and further what is the geodynamic implication for this difference. In addition, there is a lack of data for systematic geochronological comparison of granulitic xenoliths with the granulitic terrain on the same Archean cratons. We hereby present a case study of lower crust xenoliths from a well-known and documented Archean craton in Asia: the North China Craton (NCC), by SHRIMP U/Pb dating technique. A variety of deep-seated xenoliths, from felsic granulite, mafic granulite, websterite, to spinel and garnet pyroxenite in lithology, were carried up by Cenozoic basalts erupted in the Hannoba area, northern margin of the NCC, which has an Archean granulitic basement. The mineral assemblages and T-P estimations for these xenoliths indicate a 32 km petrological MOHO, and indicate that the mafic granulites are the dominant component in the lower crust, while pyroxenite xenoliths were derived from both the lower crust and the upper mantle (Chen et al, 1996). Fine-grained zircons were separated from eleven xenoliths of three lithological categories: felsic granulites (af+pl+Q), mafic granulites (cpx+opx+pl) and pyroxenites (cpx+opx). The SHRIMP U-Pb isotopic results do show a diverse age spectrum, ranging from late Archean (2.6 Ga) to Cenozoic (10 Ma). This study indicates that (A) isotopic ages of these xenoliths mostly correlate well with the regional orogenic episodes recorded on the surface, such as 2.5 Ga, 2.3 Ga, 1.8 Ga, 430 Ma, 310 Ma, 250-280 Ma, 190-200 Ma, 130-140 Ma, 120 Ma, 100-110 Ma, 80 Ma and 10 Ma; (B) the Precambrian ages, i.e. 2.0-2.5 Ga and 1.8-1.9 Ga, are only recorded in the mafic granulite and sp- or gt-bearing pyroxenite xenoliths, whereas the ages from the felsic granulite and the pyroxenite xenoliths fall in the Phanerozoic; (C) in contrast, only 2.4-2.6 Ga, 2.2 Ga and 1.8 Ga events were recorded in zircons from the nearby granulitic terrain (within 10 km). The diverse age pattern of xenoliths in this study is more complicated than those reported elsewhere up to date, and indicates that the geodynamic processes in the deep lithosphere do manifest on the surface; meanwhile, major ancient tectono-thermal records could be preserved depth. This coupling would undoubtedly place tight constraints on the genesis of these xenoliths, which is consistent with the available geochemical and Sr-Nd-Pb isotopic studies (Zhou et al., 1996). In addition, the arguments of timing, composition and T-P constraint strongly support that mixing, underplating and delamination would have been significantly involved in the evolution of deep part of lithosphere beneath the North China Craton.

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