Early Archean ultra-depleted mantle: Evidence from newly discovered ~3.8 Ga trondhjemite in North China

YAFEI WANG[1]*, XIANHUA LI[1], WEI JIN[2] AND JIAHUI ZHANG[2]

[1]Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, 100029, China (*correspondence: pengfei4783@163.com; lixh@gig.ac.cn)
[2]College of Earth Sciences, Jilin University, 130021, China

The scale and degree of early mantle depletion and continental crust growth are poorly constrained because isotopic systems of ancient rocks are susceptible to later disturbances and most reliable Hadean to Archean zircons exhibit enriched isotopic characteristics.

Detailed field and zircon isotopic studies show that our newly discovered ~3.81 Ga trondhjemite was enclosed by ~3.36 Ga migmatite complex, and variable younger ages due to various degree of ancient radiogenic Pb loss, intrusion of leucosome, and a possible new ~3.31 Ga crustal growth event.

The concordant (disc.<5%) ~3.8 Ga zircons with simple oscillatory zonings preserve the primary isotopic signatures, ranging in ε_{Hf} values from -1.9 ± 0.9 to 6.2 ± 0.7 and $\delta^{18}O$ from 5.3 ± 0.3 to 7.0 ± 0.3‰. The extremely positive ε_{Hf} values exceed values of previously reported contemporaneous zircons and existing depleted mantle Hf isotopic evolutionary models at ~3.8 Ga, providing robust isotopic evidence for the existence of an ultra-depleted mantle source corresponding to significant crustal growth at least 3.8 Gyr ago.

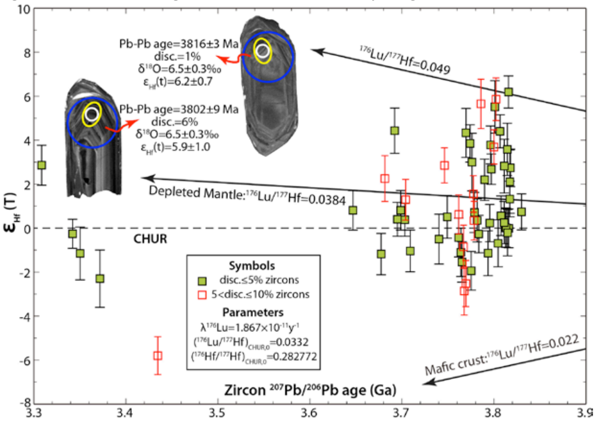

Figure 1: Plot of $\varepsilon_{Hf}(T)$ versus age of disc.<10% zircons in ~3.81 Ga unit with putative reservoirs differentiated at 4.5 Ga and details of two highest ε_{Hf} zircons. The highest ε_{Hf} value requires a reservior with $^{176}Lu/^{177}Hf$ ratio of 0.049, significantly higher than present-day depleted mantle value of 0.0384, differentiated at 4.5 Ga. The blue circle is ~60μm in diameter.

Silicate melts under high pressure

YANBIN WANG[1], TATSUYA SAKAMAKI[1,*], LAWRIE SKINNER[2], GUOYIN SHEN[3], TONY YU[1], YOSHIO KONO[3], ZHICHENG JING[1] AND CHANGYONG PARK[3]

[1]Cnter for Advanced Radiation Sources, the University of Chicago, Chicago, IL, USA
[2]Stony Brook University, Stony Brook, NY, USA
[3]HPCAT, Carnegie Institution of Washington, Argonne, IL, USA

We present our recent data on structural evolution of silicate melts and glasses at high pressures, along with measurements of density, elasticity, and viscosity. High-pressure melt structure studies were conducted using a Paris-Edinburgh Press at the HPCAT beamline 16-BM-B. Acoustic velocities were also measured on silicate glasses. A DIA apparatus was used for melt density measurements based on x-ray absorption at GSECARS beamline 13-BM-D. Structures of polymerized (jadeite – $NaAlSi_2O_6$) and depolymerized (diopside, $CaMgSi_2O_6$) melts show distinct responses to pressure. In jadeite melt, T-O (T denotes tetrahedrally coordinated Al and Si) bond length, T-T bond length, and T-O-T angle all exhibit rapid and non-linear decrease with increasing pressure to ~3 GPa. In diopside melt, these parameters vary linearly with pressure and change very little. A large viscosity dataset from the literature shows that, with increasing pressure, viscosities of polymerized liquids (including jadeite) first decrease and reach a minimum at around 3 GPa before turning over. On the other hand, viscosities of depolymerized melts (including diopsite) increase monotonically with pressure. Molecular dynamics calculations, constrained by the x-ray structural data, were employed to examine details of structural evolution in the two types of liquids. A model will be presented to link structural evolutions to changes in melt properties, such as density and viscosity, with pressure.

www.minersoc.org
DOI:10.1180/minmag.2013.077.5.23