Sr-Nd-Hf-Pb isotopic characteristics of North-Western and Southern Ethiopian lithospheric mantle

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Major and trace element abundances and Sr, Nd, Hf, and Pb isotopic compositions were determined on clinopyroxene (cpx) separates from spinel-lherzolite and spinel-harzburgite xenoliths hosted in Quaternary basanite from the North-Western Ethiopian Plateau (Injibara and Dedessa areas) and the Southern Ethiopian rift zone (Megga area). On a chondrite-normalized diagram, cpx from lherzolites show nearly flat HREE patterns from Lu to Gd ($[Gd/Lu]_N$: 1.06 to 1.24 for the plateau and 0.82 to 1.13 for the rift zone). Most samples show depleted patterns from Gd to La ($[La/Gd]_N$ = 0.11 to 0.19). The majority of samples reveal LREE depletion and the rest show LREE enrichment caused by a late stage refertilization process. The degree of depletion of LREE in cpx is smaller than those in the abyssal peridotite. In most samples, the compositional relationship between coexisting olivine (Fo_{89-90}) and spinel (Cr#=8 – 13) indicates 'fertile' residual mantle peridotite.

The $^{143}Nd/^{144}Nd$ and $^{176}Hf/^{177}Hf$ in lherzolite cpx range from 0.51321 to 0.51380 and from 0.28312 to 0.28443, respectively. Some cpx have extremely high $^{143}Nd/^{144}Nd$, higher than that of present DMM. The Sm-Nd and Lu-Hf model ages of the most LREE-depleted cpx are 0.9 and 0.5 Ga for plateau cpx and 1.7 and 1.1 Ga for rift cpx, respectively. Initial Nd and Hf isotopic compositions that are estimated using these model ages plot within the field for depleted mantle. This implies that these lherzolites were produced by melt extraction from the asthenospheric mantle during and/or before the Pan-African orogenic event.

The LREE-enriched cpx lherzolites and harzburgites have more radiogenic Sr and Pb than LREE-depleted cpx. Additionally, the former are isotopically different from host basanites. This suggests that the refertilizing metasomatic agent was generated from an enriched mantle component isotopically different from MORB source mantle. In particular, the rift xenoliths experienced more pervasive and variable metasomatism than the plateau xenoliths. Southern Ethiopian lithospheric mantle may have been influenced by melt derived from cratonic lithospheric mantle and/or hetrogeneous component in the asthenospheric mantle after the Pan-African events.

Pore size specific characterization of the adsorption of CO_2 and methane in coal using SANS

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Carbon sequestration in geological formations such as deep unminable coal seems is one of the proposed measures for arresting the rising concentration of atmospheric carbon dioxide. The efficiency of CO_2 sequestration depends crucially on the ability to predict sorption capacity of green house gases in coal. Traditionally, the sorption capacity of coal at different temperature (T) and pressure (P) has been estimated based on measurements of sorption isotherms or mercury porosimetry. However, none of the existing experimental methods allows the investigator to 'look inside pores' and monitor changes in the phase behaviour of fluid depending on the pore size. Due to the high penetration power and relatively short wavelength, small-angle neutron scattering (SANS) technique is ideally suited for assessing the phase behavior of various fluids in engineered and natural porous systems such as coal [1]. In addition, it can be used for evaluating the amount of pores, which are not connected to the percolation network and thus are inaccessible to fluid molecules. In this talk we will discuss the results of the SANS studies of the adsorption of CO_2 and methane in two coals from the Illinois basin: the Seelyville (Vigo 518) and the Springfield (IN-1). Experiments were conducted at T=23 and 60 °C, in the pressure range 1 – 400 bar. We found that the adsorption process begins at low pressure in small, sub-nanometer pores, which become filled with the adsorbed phase characterized by liquid-like density. As higher pressure, pores with progressively bigger sizes become completely filled with the fluid (CO_2 or methane). Calculations based on a newly developed approach show that the amount of micro- and mesopores, which are inaccessible to methane molecules is ~ 9% (Vigo-518) and 51% (IN-1). The volume of inaccessible pores varies as a function of the pore size. The developed approach may be applied for correlating the specifics of the coal structure with the sorption capacity and evaluating the volume of inaccessible pores in other natural porous materials of interest for CO_2 sequestration, such as saline aquifers, shales, and sandstones.

[1] Melnichenko, Radlinski, Mastalerz, Cheng & Rupp (2009) *Inernational Journal Of Coal Geol*ogy **77**, 69–79.