

A noble gas study of gabbroic lower ocean crust recovered during MODE98 at the Atlantis Bank in the Indian Ocean

Hidenori Kumagai[1], Henry J.B. Dick[2], Ichiro Kaneoka[3], Hajimu Kinoshita[4]

[1] JAMSTEC, [2] WHOI, [3] ERI, Univ. Tokyo, [4] JAMSTEC, DSR

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We report the preliminary results of noble gas measurements on five gabbro samples showing a range of primary mineral compositions and varying degrees of crystal-plastic deformation. These were recovered during research cruise MODE98Leg4 (Oct.-Nov.'98), at the Atlantis Bank in the Indian Ocean (32.6S,57.2E). The measurements were mainly intended to increase our knowledge of the noble gas signatures in the lower oceanic crust.

As a result, MORB-like $^3\text{He}/^4\text{He}$ ratios were observed, meaning that the source materials of these gabbros are similar to present days MORBs. And ^3He content as a primordial component seems to be related to the lithological units, meaning further analysis could provide information on the magmatic processes.

Noble gases are well-established tracers for investigating the chemical structure and evolution of the Earth's interior. So far, noble gas studies of plutonic rocks from the lower crust are limited, especially for the ocean crust. Here we report the preliminary results of noble gas measurements on five gabbro samples showing a range of primary mineral compositions and varying degrees of crystal-plastic deformation. These were recovered during research cruise MODE98Leg4 (Oct.-Nov.'98), at the Atlantis Bank in the Indian Ocean (32.6S,57.2E). The measurements were intended 1) to increase our knowledge of the noble gas signatures in the lower oceanic crust, and 2) to investigate whether oceanic gabbros retain their magma-derived noble gas signature.

Gases in whole rock samples were extracted by 2-step heating and purified. Five noble gases (He - Xe) were quantified and their isotopic compositions determined by mass spectrometer at the Earthquake Research Institute of the University of Tokyo. The main results are as follows. 1) Samples showed abundance patterns with the light noble gases enriched and the heavy ones depleted similar to MORB and plutonic rocks from continental areas, except for He which is two order of magnitude less in concentration. 2) Indian MORB-like (7.98 ± 0.69 RA; Hilton et al., 1993) $^3\text{He}/^4\text{He}$ ratios were observed by step-heating. 3) $^{40}\text{Ar}/^{36}\text{Ar}$ ratios are quite low, with 1300 measured as a maximum during step heating. 4) The most heavily altered and deformed sample (6K466R10) shows quite low $^3\text{He}/^4\text{He}$, mainly due to low content of ^3He as a primordial component. 5) Except for above mentioned sample, ^3He content seems to be related to the lithological units not to rock type variation.

Such characteristics could be interpreted as follows: 1) Based on $^3\text{He}/^4\text{He}$ ratios, the source materials of these gabbros are similar to present days MORBs in the Indian Ocean. 2) Significantly low $^{40}\text{Ar}/^{36}\text{Ar}$ ratios might be the result of seawater alteration. Such signatures are consistent with the Ne and Xe isotopic ratios, which are indistinguishable from atmospheric. 3) The quite low $^3\text{He}/^4\text{He}$ ratio of sample 6K466R10 could be interpreted as loss of primordial noble gases and accumulation of radiogenic ^4He . 4) Variations in ^3He content related to the lithological units, rather than simply rock type, means that further analysis could provide information on the magmatic processes such as magma mixing, supply rate, and solidification process.