Drilling a juvenile oceanic arc and a comparison with the northern Oman ophiolite

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Abstract

The Oman ophiolite has been considered as an on-land analog for oceanic lithosphere formed at mid-ocean ridge. However, recent studies of northern Oman ophiolite show significant influence from subsequent subduction zone processes. Thus, the Oman ophiolite is one of ideal places to study juvenile oceanic arc system. Moreover, the results from the Oman ophiolite can be directly compared with a reference crust and mantle section in young oceanic arc such as the Izu-Bonin-Mariana forearc. According to the recent observations of southern Mariana forearc the petrogenesis of peridotites seems very similar to the northern Oman peridotites: i.e., they were residues after partial melting at mid-ocean ridge and later influenced by fluid at forearc environment. To study the evolution of an oceanic lithosphere to a juvenile oceanic arc system, the southern Mariana forearc will be one of the targets for the 21 century Mohole project using a riser vessel “CHIKYU”. A comparison of drilled materials with on-land analog from the Oman ophiolite will significantly advance our knowledge of island arc evolution.

The Oman ophiolite has been considered as an on-land analog for oceanic lithosphere formed at mid-ocean ridge (e.g., Nicolas, 1989). However, the studies of the northern Oman ophiolite show significant influence from subsequent subduction zone processes (e.g., Tamura and Arai, 2006; Arai et al., 2006; Dare et al., 2008). We have investigated spatial compositional variability in the mantle section of Fizh block, the northern Oman ophiolite (Fig. 1; Takazawa et al., 2008). The southern part of Fizh block mainly consists of relatively homogeneous harzburgites while the northern part consists of both less-depleted harzburgites and highly-refractory harzburgites such that Cr# [=100 x Cr/(Cr+Al)] ratio of spinel widely ranges from 24.2 to 77.6 contrasting to the range of spinel Cr# in the south from 55.6 to 63.2. These results indicate that the uppermost mantle in the north where a segment end was located is more heterogeneous in basaltic components relative to the south where a segment center was located. The localized highly-refractory zone in the north Fizh indicates that the residues after partial melting at mid ocean ridge were subjected to hydrous remelting during detachment of oceanic lithosphere. Our results combined with previous studies demonstrate that the Oman ophiolite is an ideal place to study both crust and mantle processes in a juvenile oceanic arc system. Moreover, the results from the Oman ophiolite should be directly compared with a reference crust and mantle section in young oceanic arc such as the Izu-Bonin-Mariana forearc.

Drilling and coring of crust and mantle rocks are an attractive strategy for obtaining intact forearc lithosphere. In this moment I have no clear idea where is an appropriate place for drilling. However, recent observations of southern Mariana forearc by submersible Shinkai 6500 have advanced our knowledge of forearc mantle wedge (e.g., Ohara and Ishii, 1998; Fig. 2). The petrogenesis of peridotites seems very similar to the northern Oman peridotites: i.e., they were residues after partial melting at mid-ocean ridge and later influenced by fluid at forearc environment (Ohara and Ishii, 1998). Although the drilling of deep sea floor in the southern Mariana forearc may be associated with technological difficulties I would like to stress a high potentiality in drilling an entire section of forearc crust and mantle wedge in this area. The southern Mariana forearc could be one of the targets for the 21 century Mohole project using a riser vessel “CHIKYU”. A comparison of drilled materials with the on-land observations from the Oman ophiolite will significantly advance our knowledge of island arc evolution.

References
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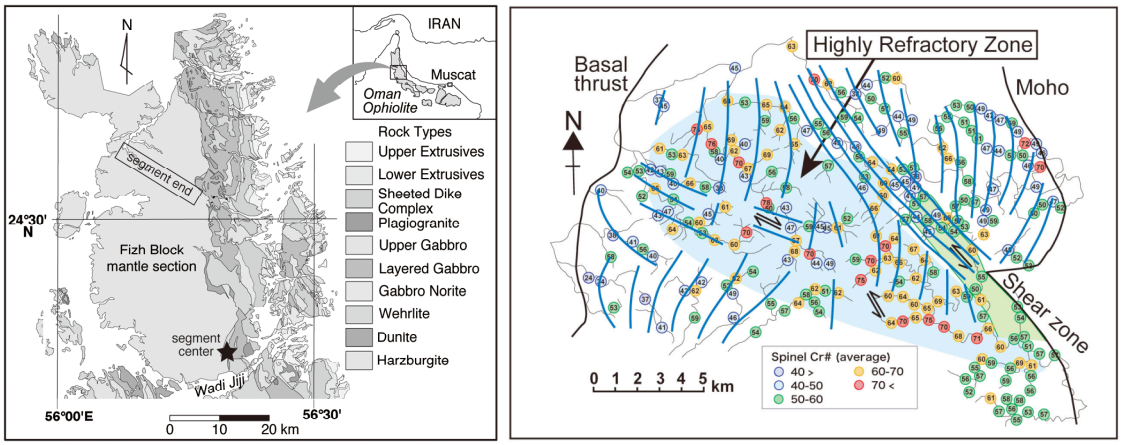

Fig. 1 (right) Geological map of the Fizh block, northern Oman ophiolite. (left) spatial variations of spinel Cr# in the northern Fizh block.

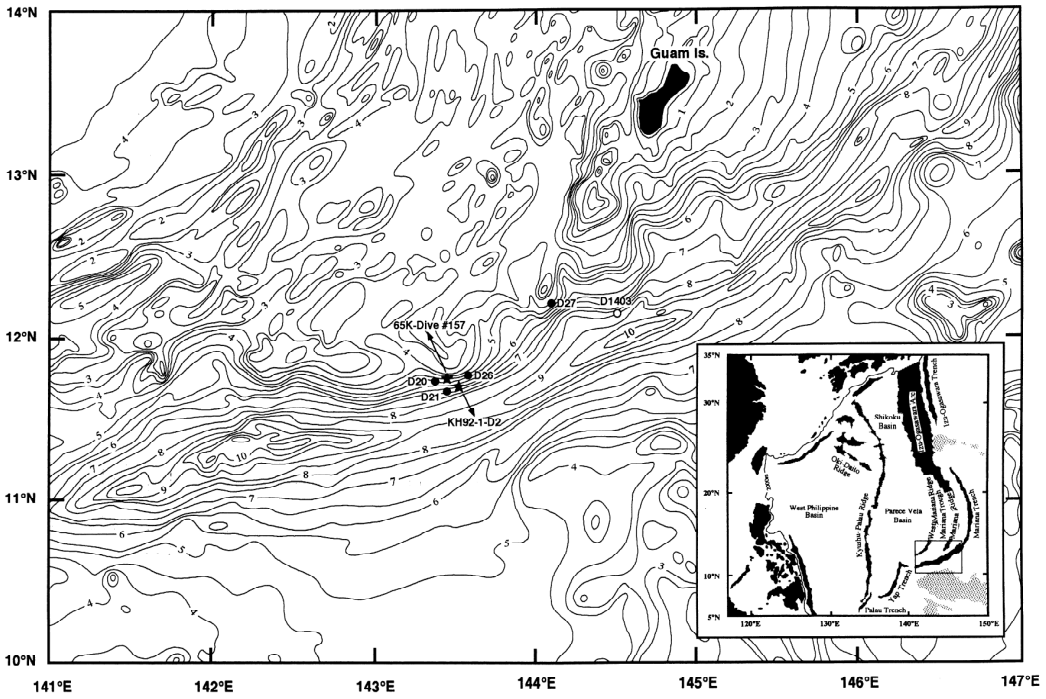

Fig. 2 Topography in the vicinity of the southern part of the Mariana Trench. Fig. 1 of Ohara and Ishii (1998).