Lithos 124 (2011) 185–199

Contents lists available at ScienceDirect

Lithos

journal homepage: www.elsevier.com/locate/lithos

Deformation and hydrothermal metamorphism of gabbroic rocks within the Godzilla Megamullion, Parece Vela Basin, Philippine Sea

Yumiko Harigane [a,b,*], Katsuyoshi Michibayashi [a,b], Yasuhiko Ohara [c,d]

[a] Graduate School of Science and Technology, Shizuoka University, Shizuoka 422–8529, Japan
[b] Institute of Geosciences, Shizuoka University, Shizuoka 422–8529, Japan
[c] Hydrographic and Oceanographic Department of Japan, Tokyo 104–0045, Japan
[d] Institute for Research on Earth Evolution, Japan Agency for Marine-Earth Science and Technology, Kanagawa 236–0016, Japan

ARTICLE INFO

Article history:
Received 15 March 2010
Accepted 2 February 2011
Available online 12 February 2011

Keywords:
Gabbroic rock
Mylonite
Ultramylonite
Shear zone
Godzilla Megamullion
Parece Vela basin

ABSTRACT

Microstructural and petrologic analyses of 7 gabbroic rocks sampled from the medial area of the Godzilla Megamullion (site KH07-02-D18), located along the Parece Vela Basin spreading ridge (Parece Vela Rift), Philippine Sea, reveal the development of a high-temperature ductile shear zone associated with hydrothermal metamorphism in the lower crust. The deformed gabbroic rocks are petrographically classified into mylonites and an ultramylonite, and are characterized by porphyroclastic textures consisting mainly of coarse plagioclase and clinopyroxene/amphibole porphyroclasts in a fine-grained matrix. Plagioclase crystallographic-preferred orientations vary from (010)[100] and (001)[100] patterns in the mylonites to a weak (001)[100] pattern in the some mylonites and ultramylonite, suggesting a change in the deformation mechanism from dislocation creep to grain-size-sensitive creep with increasing intensity of deformation. The chemical composition of matrix plagioclase is generally more sodic than that of porphyroclasts. Secondary amphibole is ubiquitous, consisting mainly of pargasite and magnesiohornblende (brown hornblende) and actinolite (green hornblende). The mineral assemblage is consistent with the hydrothermal metamorphic reaction: clinopyroxene + calcic plagioclase + fluid → amphibole + sodic plagioclase. Compared with deformed gabbroic rocks from the breakaway and termination areas of the Godzilla Megamullion, the samples record ductile shearing under high temperature conditions, possibly related to the development of the Godzilla Megamullion, although hydrothermal activity in the medial area appears to have been less intense than in both the breakaway and termination areas.

1. Introduction

Megamullions form by amagmatic extension and were first identified along the Mid-Atlantic Ridge (e.g., Blackman et al., 1998; Cann et al., 1997; Karson, 1990; Tucholke and Lin, 1994; Tucholke et al., 1998). Megamullions usually occur close to the intersection of a transform fault and a spreading ridge, and are characterized by a domal surface, surface corrugations oriented parallel to the spreading direction, a high mantle Bouguer anomaly, and exposed lower crust and mantle material (e.g., Blackman et al., 1998; Tucholke et al., 1998). By analogy to continental metamorphic core complexes, they are commonly interpreted as oceanic core complexes (OCCs), representing the exhumed footwall of an oceanic detachment fault (e.g., Blackman et al., 1998; Cann et al., 1997; Christie et al., 1998; Dick et al., 1991, 2000, 2008; Escartin et al., 2003; Ildefonse et al., 2007; Karson, 1990, 1999; Kumagai et al., 2006; MacLeod et al., 2002, 2009; Martinez et al., 1998; Miranda and John, 2010; Morishita et al., 2009; Okino et al., 2004; Reston et al., 2002; Schroeder and John, 2004; Smith et al., 2008; Tucholke et al., 1998).

An extremely large megamullion from the Parece Vela Rift in the central Parece Vela Basin, Philippine Sea, is located on the southwest flank of the inactive S1 spreading segment (Fig. 1; Ohara et al., 2001). Topographic corrugations oriented perpendicular to the spreading segment are clearly visible across the surface of the complex, extending 55 km along and 125 km perpendicular to the axis, covering an area about 10 times larger than the megamullions that occur along the Mid-Atlantic Ridge (Fig. 1; Ohara et al., 2001). In appreciation of its remarkable size, Ohara et al. (2003a) named this the Godzilla Megamullion.

We investigated deformed gabbroic rocks collected from several sites (Fig. 1) since 2005 (Harigane, 2009) in order to understand the structural evolution of the lower crust. As the first part of this project,

* Corresponding author at: Department Earth and Atmospheric Sciences, University of Houston, 312 Science & Research, Building 1, Houston, TX 77204–5007, USA. Tel.: +1 713 743 3399; fax: +1 713 748 7906.
E-mail addresses: harriet_0322@hotmail.com, yharigane@uh.edu (Y. Harigane).

0024-4937/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.lithos.2011.02.001

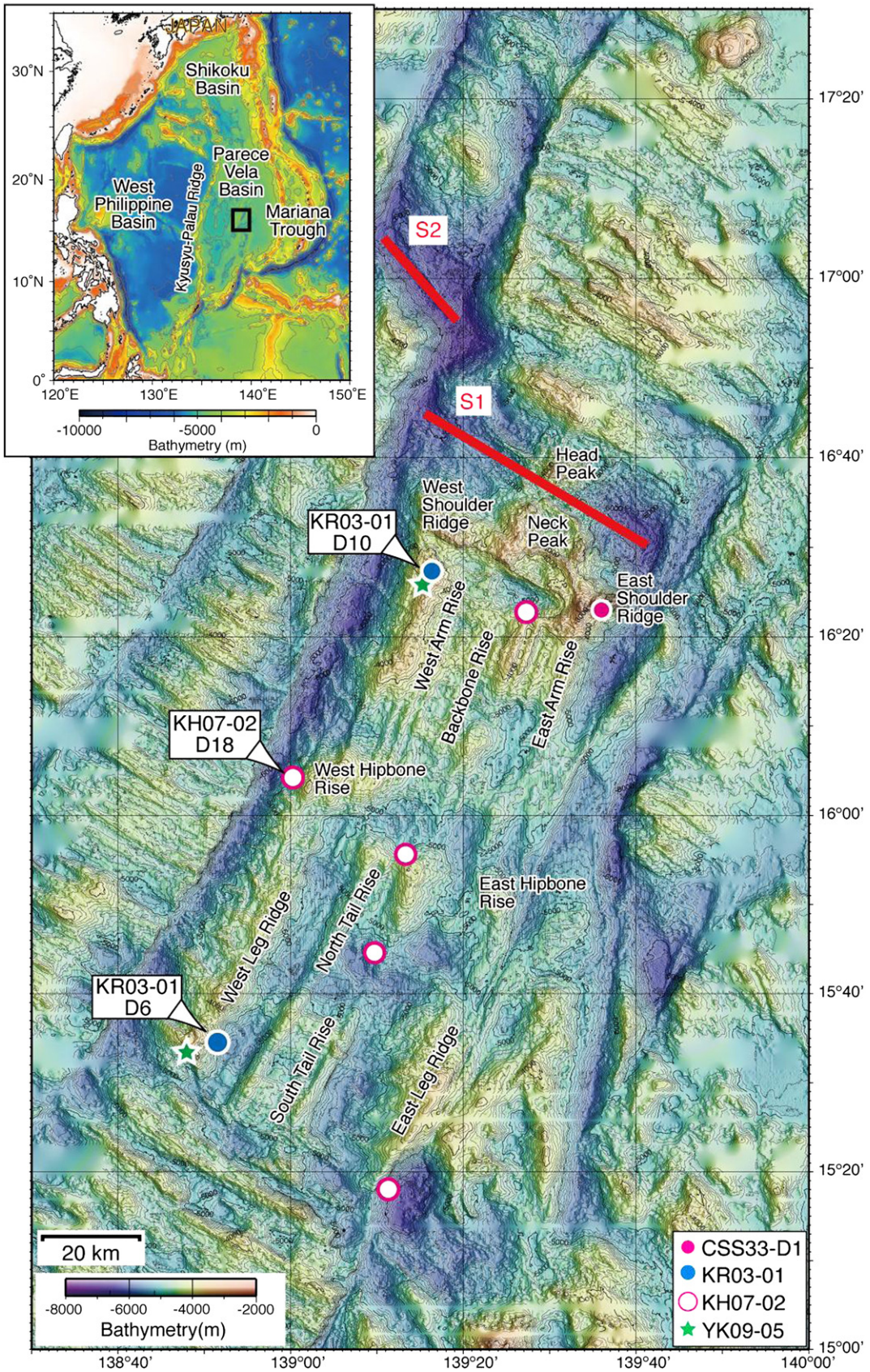

Fig. 1. The inset map shows the major bathymetric features of the Western Pacific (after Ohara et al., 2001). The black square shows the study area at the site of the Godzilla Megamullion, Parece Vela Basin. The main map is a bathymetry map of the Godzilla Megamullion (as outlined by the dashed line), showing the locations of dredge sites and dives that recovered gabbroic rocks during cruises CSS33, KR03-01, KH07-02-Leg2/Leg4, and YK09-05. The location of site KH07-02-D18 is shown by the red star. The inactive spreading segments S1 and S2 (Ohara et al., 2001) are marked by thick red lines. The 13 topographic names in the Godzilla Megamullion were named by Ohara and Snow (2009).