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The Central Basin Spreading Center in the Philippine Sea: Structure of an extinct spreading center and implications for marginal basin formation

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[1] Newly acquired marine geophysical data along the Central Basin Spreading Center (CBSC), the extinct spreading axis of the West Philippine Basin (WPB), display along-axis variations of spreading style. We have described and analyzed the tectonic spreading fabric and segmentation patterns along a 1000-km-long section of the fossil ridge between 126°00′ and 133°30′E. ''Slow-spreading features'' (deep rift valleys and nodal basins, rough abyssal hills on the ridge flanks, and mantle Bouguer anomaly lows beneath segment centers) are observed in the eastern CBSC. In contrast, ''fast-spreading'' features (overlapping spreading centers, volcanic axial ridges, and smooth abyssal hill fabric) are identified along the western CBSC. We attribute the large morphological and geophysical variations along the CBSC to higher melt supply in the western region caused by high mantle temperature and/or mantle heterogeneity, which may be related to a relatively small-scale mantle plume forming the oceanic plateaus located in the WPB. Another prominent feature of the CBSC is the development of a deep valley oblique to the spreading fabric. Reconstructions of the plate boundary geometry through time, using abyssal hill geometry as well as other measurements, provide evidence for a later stage of amagmatic extension (i.e., reactivation) along the CBSC after the formation of the main basin. This stage is dominated by tectonic deformation with minor amounts of volcanism (mainly located in eastern segments), resulting in the observed surface brittle deformation distributed within a broad zone of ductile deformation. *INDEX TERMS:* 3035 Marine Geology and Geophysics: Midocean ridge processes; 3045 Marine Geology and Geophysics: Seafloor morphology and bottom photography; 3010 Marine Geology and Geophysics: Gravity; 3040 Marine Geology and Geophysics: Plate tectonics (8150, 8155, 8157, 8158); 3005 Marine Geology and Geophysics: Geomagnetism (1550); *KEYWORDS:* marginal basin formation, seafloor morphology, extinct spreading center, Philippine Sea

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1. Introduction

[2] Geophysical and geochemical observations combined with model studies show that one key parameter controlling mid-ocean ridge processes is the spreading rate [*MacDonald*, 1988; *Parmentier and Phipps-Morgan*, 1990; *Lin and Phipps-Morgan*, 1992]. Recent studies have pointed out that mantle temperatures [e.g., *Cochran et al.*, 1997] and chemical heterogeneities in the upper mantle [*Niu et al.*, 2001] are also critical factors governing ridge process. Ridge morphology, gravity signature, chemical variability, and segment geometry exhibit large variations between fast-spreading and slow-spreading ridges, and the transition occurs at spreading rates in the 50–80 mm/yr. range [*Small*, 1994]. How plate kinematics, mantle upwelling, and decompression melting variations result in such large differences is a basic question in understanding crustal accretion. Most of our knowledge of accretion processes is based on studies of active fast-spreading and slow-spreading midocean ridges, primarily the East Pacific Rise and the northern Mid-Atlantic Ridge. Spreading systems in marginal basins are important sites of crustal accretion; however, back arc basins and other marginal basins have not been studied from the perspective of morphotectonic variations nearly as intensely as have been fast-spreading and slow-spreading midocean ridges. Back arc basins often show more complicated tectonic fabric, higher heat flow values, greater depths, and different basalt chemistry. In this paper we present the morphological and geophysical characteristics along an extinct spreading center in a marginal basin, the Central Basin Spreading Center (CBSC), in the western Philippine Sea. The CBSC is

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