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A detailed study of the Gagua Ridge: A fracture zone uplifted during a plate reorganisation in the Mid-Eocene

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Abstract

Recent multibeam bathymetric and geophysical data recorded in the West Philippine Basin, east of Taiwan, reveal new information on the structure and the tectonic origin of the oceanic Gagua Ridge. This linear, 300 km-long, 4 km-high, north-south-trending ridge, is being subducted beneath the Ryukyu Trench along 123° E. This basement high separates two basins of different ages. Its summit is marked by two crests and an axial valley. A map of the basement top shows the region of the ridge to be composed of a set of linear and parallel ridges and troughs. All these elements suggest that the development of the ridge, and its surroundings, has been influenced by strike-slip deformation. Nevertheless, the height of the ridge indicates also an important compressive component in the deformation. Gravity models across the ridge show local compensation with a crustal root, indicating that an overthickening of the crust occurred when it was young and thus more easily deformable. This idea is strengthened with flexural modeling of the lithosphere that bends under the load of the ridge, indeed it indicates that the high probably formed when the underlying lithosphere was young. We interpret the Gagua Ridge as a fracture zone transverse ridge uplifted during a transpressive episode along a north-south -trending fracture zone in the middle Eocene time, if we accept Hilde and Lee's (1984) model of magnetic lineations. This tectonic event could be contemporaneous with a change of the pole of rotation of the West Philippine Basin which occurred about 43/45 Ma ago.

Introduction

Topography of the world's seafloor is becoming increasingly investigated, using satellites, side-scan sonar and multi-beam echo sounder. Many seafloor topographic features can now be recognized with good resolution, especially the oceanic spreading centers and subduction trenches. However, the largest areas of the bottom of oceans consist of sedimented abyssal plains, in which we can observe submarine plateaus, volcanoes, and aseismic ridges. One unusual feature of the oceanic seafloor is the Gagua Ridge, which lies in the northwestern edge of the Philippine Sea Plate near Taiwan (Figure 1).

The Gagua Ridge is a major narrow, linear high which separates two oceanic basins of the Philippine Sea Plate. This N–S trending ridge deepens and seems to vanish northward in the Ryukyu subduction zone. The origin of this prominent ridge has remained enigmatic. It has been interpreted as a trench-slope break of an inactive subduction zone (Karig and Wageman, 1975), an extinct spreading center (Bowin et al., 1978), an uplifted sliver of oceanic crust, perhaps similar to ridges bounding fracture zones (Mrozowski et al., 1982), and as a 'feature related to an early Tertiary subduction zone which existed to the eastern margin of Luzon' (Evans and Lewis, 1984). In addition, Sibuet and Hsu (1997) have proposed that north of 23° N, the Gagua Ridge could have been a plate boundary between the Philippine Sea and Huatung plates.