OPHIOLITES AND PLATE TECTONICS

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The term ephiolite refers to a succession of rocks. Ideally, it comprises tectonized (mantle) ultramafic rocks at the base, through cumulate ultramafic and gabbroic rocks, isotropic gabbros, sheeted (mafic) dykes, basaltic pillow lavas, to pelagic sediments (chert, mudstone, shale, limestone) at the top. Ophiolites represent one of the very best examples of emplacement and crystallization of magma. Previously referred to as the roots of the Alpine-type orogenic belts, they are tectonically emplaced into highly deformed thrust sheets and fold belts. Hence, intact sections are rare and most of them occur as dismembered blocks, and/or megabreccia in mélange zones. Ophiolites have been reported in rocks of all ages. Some of the better known occurrences are from the Tethyan zone: Troodos (Cyprus), Samail (Oman), Bela-Zhob (Pakistan), Xigaze (southern Tibet), and Papua-New Guinea. The Samail ophiolite, one of the best studied, is considered to have formed at a Cretaceous ridge crest near the present day month of the Persian Gulf and thrust westward over much older rocks of the Arabian Peninsula.

The succession of rocks in ophiolites corresponds with that of the oceanic crust and its underlying mantle. The two also display similarities in structural, textural, petrographic, and geochemical characteristics. Hence, it has been argued that most, if not all, ophiolites formed along spreading ridges and were emplaced as slivers of oceanic crust and mantle during collision of plates. However, this may be a simplistic view and a number of questions needs to be addressed. To begin with, ophilites are not uniform in characteristics and show variation in thickness, lithology, and geochemistry. Most of them are thinner than the oceanic crust. Petrologic features of the ophiolites can be better explained by invoking large magma bodies under the rather dynamic modern ocean ridges. Although such chambers have been proposed under fast spreading ridges, there is no geophysical evidence to support this view. A tentative explanation for this is that the magmatism is repeated in episodes and we are at a time with no large magma bodies (McBirney, 1984; Igneous Petrology). There also is the issue of distinctly lower P wave velocities in ophiolite lithologies than in normal oceanic crust rocks. This may be related to mineralogical changes due to pervasive hydrothermal metamorphism. It is likely that ophiolites may have originated in a variety of environments from ocean ridges to marginal basins, back-arc basins, and intra-arc basins. Whatever their origin, ophiolites are manifestation of major tectonic events that are the result of collisional processes responsible for orogeny, deformation, and earthquakes.

Ophiolite occurrences have been used in demarcating collision boundaries (suture zones) between plates. A series of ophiolites defines the zone along which the northern (sub- Continental) part of the Indian plate was sutured to other (mainly Asiatic) blocks during the Cretaceous to Early Tertiary: Bela, Zhob, Waziristan ophiolites in the west, Dargai, Shangla (Kohistan), Spongtang (Ladakh), Xigaze (southern Tibet) ophiolites in the north along the Indus-Zangbo suture, and Nagaland and Indeman-Nicobar ophiolites in the east. Petrologic studies of the major ophiolites of Pakistan (Arif and Jan, 2006; J. Asian Earth Sci., vol. 27) shows that not all of them have ocean ridge origin. Suggestions range from ocean ridge to back-arc and marginal basins, oceanic fracture (leaky transform) zone, and island arc. Some comprise a chaotic mixture of lithologies of different tectonic settings in ophiolitic mélanges, and may have complex origin.