DSPMU UNIVERSITY, RANCHI.
DEPARTMENT OF GEOLOGY

M.Sc. SEMESTER-II **DATE-24/04/2020**

OPHIOLITES

Ophiolites are assemblage of temporally and spatially associated ultramafic, mafic, and felsic rocks that are interpreted to be remnants of ancient oceanic crust and upper mantle. Ophiolites occur in areas where obduction (the opposite of subduction) has pushed a section of oceanic lithosphere onto continental crust (Figure-1). During this process, most ophiolite sequences have been highly deformed and hydrothermally altered. Nevertheless, it is often possible to look through the deformation and alteration and learn something about the structure of oceanic lithosphere.

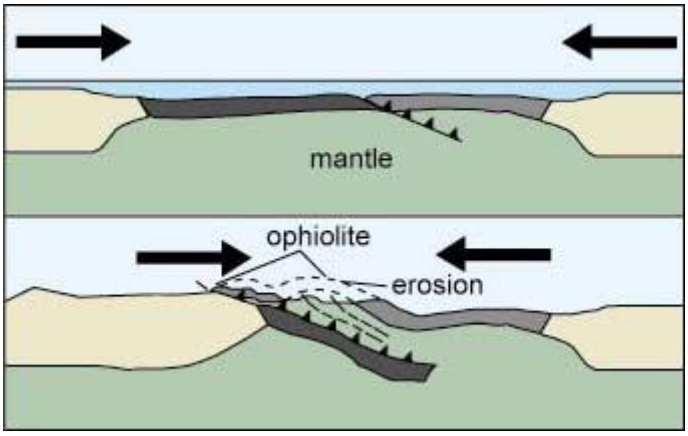
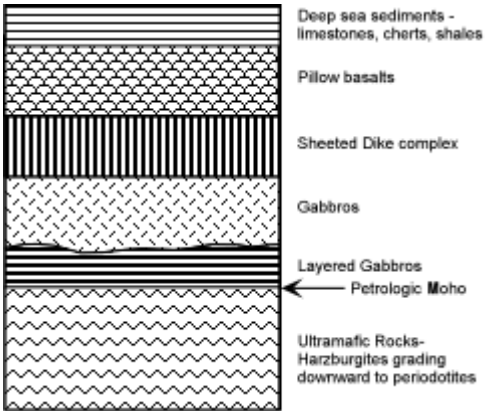


Figure-1

An **idealized ophiolite sequence** (Figure on the right) shows an upper layer consisting of deep sea sediments (limestones, cherts, and shales), overlying a layer of pillow basalts. Pillow basalts have a structure consisting of overlapping pillow-shaped pods of basalt. Such pillow structure is typical of lavas erupted under water. The pillow basalts overly a layer consisting of numerous dikes, some of which were feeder dikes for the overlying basalts. Beneath the sheeted dike complex are gabbros that likely represent the magma chambers for the basalts. The upper gabbros are massive while the lower gabbros show layering that might have resulted from crystal settling.



At the base of the layered gabbros there is a sharp increase in the density of the rocks, and the composition changes to ultramafic rocks. This sharp change in density is correlated with what would be expected at the base of the crust, and is thus referred to as the petrologic moho. At the top of the ultramafic sequence the rock type is harzburgite (Ol + Opx), a rock type expected to be the residual left from partially melting peridotite. The base of the ultramafic layer is composed of peridotite.

An typical example is-

The **Samail ophiolite** (Figure-2 and 3) in south-eastern Oman that has probably been studied in the greatest detail. The rocks probably formed in the Cretaceous not far from the what is now the Persian Gulf. The rocks were later thrust (pushed uphill at a low angle) westward onto the Arabian shield. The base of the sequence is sedimentary rocks of the Arabian shield, not part of the ophiolite, on which the oceanic plate was pushed. From base to top the ophiolite is made of: peridotite, layered gabbro, massive gabbro, dikes, and volcanic rocks. At Samail this entire sequence is 15 km thick. The basal peridotite is made of a rock called harzburgite (made mostly of the minerals olivine and enstatite). Within the peridotite are many dikes of gabbro and dunite. The peridotite is deformed. The peridotite is overlain by dunite (an intrusive igneous rock made mostly of the mineral olivine) that grades upward to gabbro (an intrusive igneous rock made mostly of plagioclase and clinopyroxene - augite). The sequence is capped by dikes and volcanic rocks (pillow basalts that erupted on the ocean floor).

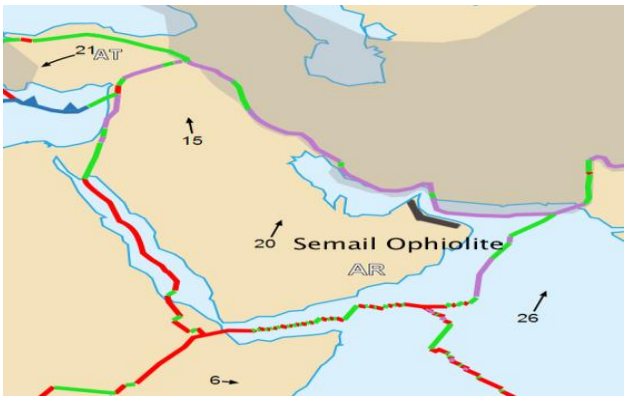


Figure-2

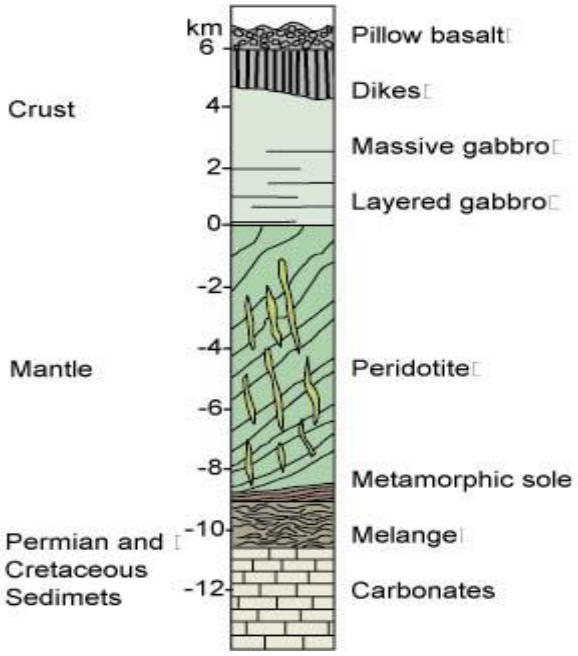


Figure-3

Petrologic classification of ophiolites

Ophiolites may have formed either at divergent plate boundaries (mid-oceanic ridges) or convergent plate boundaries (supra- subduction zones; i.e. island arcs and marginal basins). They are called MOR and SSZ types, respectively. These types are identified by chemical composition of the rocks and minerals in comparison with those from various tectonic settings on the earth at present.

Ophiolitic mantle peridotite is the refractory residue after extraction of basaltic melt through partial melting processes in the mantle. Although primary mantle peridotite may be lherzolite with abundant clinopyroxene, it changes into clinopyroxene-poor (or -free) harzburgite as the degree of melting increases (Figure-4). The mantle peridotite samples dredged from the mid-oceanic ridges are mostly lherzolite, while those dredged from supra-subduction zones (trench walls) are mostly harzburgite.

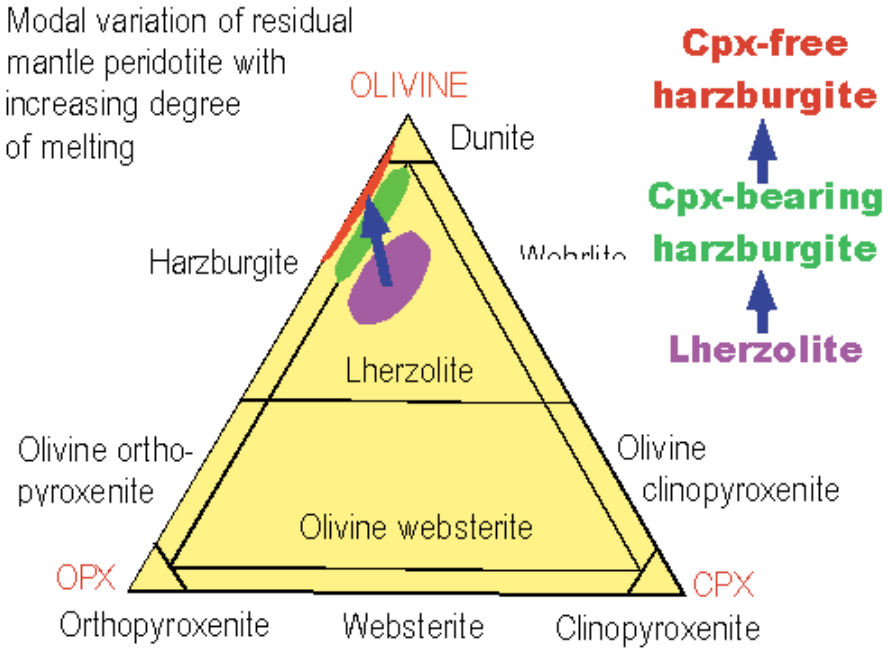


Figure-4

Significance of ophiolites

Their great significance relates to their occurrence within mountain belts such as the Alps and the Himalayas, where they document the existence of former ocean basins that have now been consumed by subduction. This insight was one of the founding pillars of plate tectonics, and ophiolites have always played a central role in plate tectonic theory and the interpretation of ancient mountain belts.