Dynamics of mantle plume head: the cases of Afar Plume and Deccan Plume

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The extent of activity of plume head in terms of time and space is still poorly constrained. The Afar Plume, the youngest mantle plume on the earth, impinged to the surface lithosphere at 30 Ma in the northeastern part of Africa and initiated intensive continual breakup between Africa and Arabia as well as the voluminous eruption of the Ethiopian Flood Basalts. We studied the offshore volcanism of the Gulf of Aden and confirmed that the activity of Afar plume head is still active and traceable. In the center of the Gulf we observed a strong point source of hotspot-like activity on the spreading ridge axis of the Gulf of Aden rift system. We can also observe a series of point-source type young volcanism on Arabia Peninsula and in the Red Sea which are arranged as a circler shape with a center at the Afar. These volcanisms appear to be correlated to the fringe of the Afar mantle plume. The activity of the point-source volcanism along a fringe of plume head seem to be sporadically active in time and space, which suggests some turbulent dynamics within the plume head 30 my even after its impingement. The Deccan Plume, the most typical mantle plume on the earth, also provides information critical to study dynamics of the plume head.

The Deccan Plume impinged to the surface lithosphere at the present position of the Reunion Island which itself is a hot spot as a relic of plume tail of the initial Deccan Plume. The most profound observation of the dynamics of the Deccan plume head comes from the magnetic anomaly lineation data on the seafloor in the southern Indian Ocean which provides reconstruction information of the India Plate. The motion of the India Plate is apparently controlled by the impingement of the Deccan Plume to the surface lithosphere at 65 Ma. The northward motion of the India Plate is accelerated up to 20 cm/yr, the highest plate motion rate in the past 200 Ma, in correlation to the impingement of the Deccan Plume. The acceleration started 20 my before the impingement, which we cannot find reasonable explanation in terms of plume dynamics. However, it is clear that the plume head of Deccan Plume affects the motion of surface plates intensively probably by decreasing viscosity beneath the lithosphere. The post impingement activity was traced on the Chagos-Laccadive Ridge to the south of the Deccan Trap into the Indian Ocean. The successive intensive volcanism duration of 25 my is observed by reconstructed volume of volcanism from the topography of the Chagos-Laccadive Ridge.

The Author will discuss the dynamics of the plume head after impingement and its interaction with lithosphere based on the comparative study of the Afar Plume and the Deccan Plume.