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Emplacement of Dyke Swarms, Cretaceous Volcanism and Development of Petroliferous Basins in and around Peninsular India

Kiran. S. MISRA[1] and Anshuman MISRA[2]

1 University of Petroleum and Energy Studies, Dehradun – 248007, India;
2 Kumaun University, Nainital - , India

We illustrate intricate genetic relationship between prolonged extensional tectonics, formation of several sedimentary basins, enormous Cretaceous volcanism and emplacement of great dyke swarms as well assequential development of hydrocarbon pools. Tectonic structures, volcanic features anddykes in land areas are mapped by field methods, assisted by interpretation of aerial photographs and satellite imagery. In covered areas, sedimentary basins and oceanic regions seismic, drill hole logs and aeromagnetic data setsare utilized. Volcanic units are found interlayered with fossiliferous sediments and form an interesting volcano-sedimentary sequence. This sequence represents approximately 90 million years, from beginning to the end of Cretaceous. It is logged in all the petroliferous basins related to subsiding rift and grabens, off-shore areas and laterally continues to oceanic regions. These observations do not support the idea that the volcanism is due to location of hot spot below the northerly moving Indian plate.

Mapping of dyke swarms and integration with seismic anddrill hole logs has been very rewarding both in our understanding the geological events, as well as for the exploration of hydrocarbons. ENE-WSW trending dyke swarm is largely enclosed within the Narmada-Tapti Tectonic Zone, while NNW-SSE trending swarm is located on the eastern shoulder of Cambay graben. The study has helped to identify two more dyke swarms from surrounding oceanic regions. The first one is located along the Gulf of Kutch and the other along the Lakshadweep chain of islands. Vertical gradient derivative of aeromagnetic data has helped to demarcate bifurcation and continuance across the graben.Parallelism of swarms with the rift and grabens has suggested that both are genetically related to each other and have developed during extensional tectonism. Exact similarity of major, trace and Rare Earth Elements (REE) in volcanic units and dykes are other interesting observations. Furthermore, location of effusive zones and centers, igneous complexes along and confined presence of dolerite and lamprophyre dykes, transecting coal bearing Gondwana sediments, within the rift and grabens, has alsosubstantiated their mutual relationship. Characteristic shape and clustering pattern of effusive centers and emanating pattern of lava channels and tubes, have explained that there were volcanic fields. These fields were located at different levels and are closely aligned along major rift and grabens. The important fact that has emerged from this study is that the volcanism and dyke emplacement is rift related. Initial felsic volcanism was followed by tholeiitic and alkaline complexes and plugs and corresponding dykes. This has suggested that the magma was generated by decompression. At shallower depths melting of sialic lithosphere was the main cause for the felsic component. In turn this was followed by predominant tholeiitic units, as nearly vertical faults reached to deeper levels and finally gave rise to alkaline complexes and dykes.No evidences to support either the presence of hot spot or its trail are found. Ratherundisturbed continuance of rift and grabens as well as dyke swarms across theproposed trail further negates the idea.

Emplacement of swarms represents only ephemeral period during prolonged extensional tectonics. Petroliferous basins have developed both during earlier Mesozoic and post emplacement Tertiary successions. Giant hydrocarbon producing Ankaleshwar field is located in the Cambay graben and in the middle of ENE-WSW trending dyke swarm. In this field both source and reservoir rocks are of Tertiary period. Several fields in Krishna-Godavari basin are producing hydrocarbons from both Pre-Cretaceous and Tertiary sequences. However, fields in Kaveri basin are largely producing from underlying pre-volcanic sequences. Furthermore, nearly vertical fractures developed in pre emplacement period acted as conduits for upward movement of fluids and heat

* Corresponding author. E-mail: drksmisra@gmail.com

for distillation of sediments. Successive volcanic units also act as favorable reservoir rocks, due to both primary and secondary porosity/ permeability. Raageshwari field in Barmer basin, Ingoli and Padhra in Cambay are prolific producers of natural gas while volcanic Rajol formation in Krishna-Godavari basin produces both oil and gas. Massive units have, however, formed oil seals for hydrocarbon trapping. Similar geological settings are also recognized in Mexican Gulf, Niger basin, South China Sea and several other basins around the globe. An integrated exploration strategy for such geological settings with dyke swarms and volcanic units is formulated for suitable utilization in comparable areas.