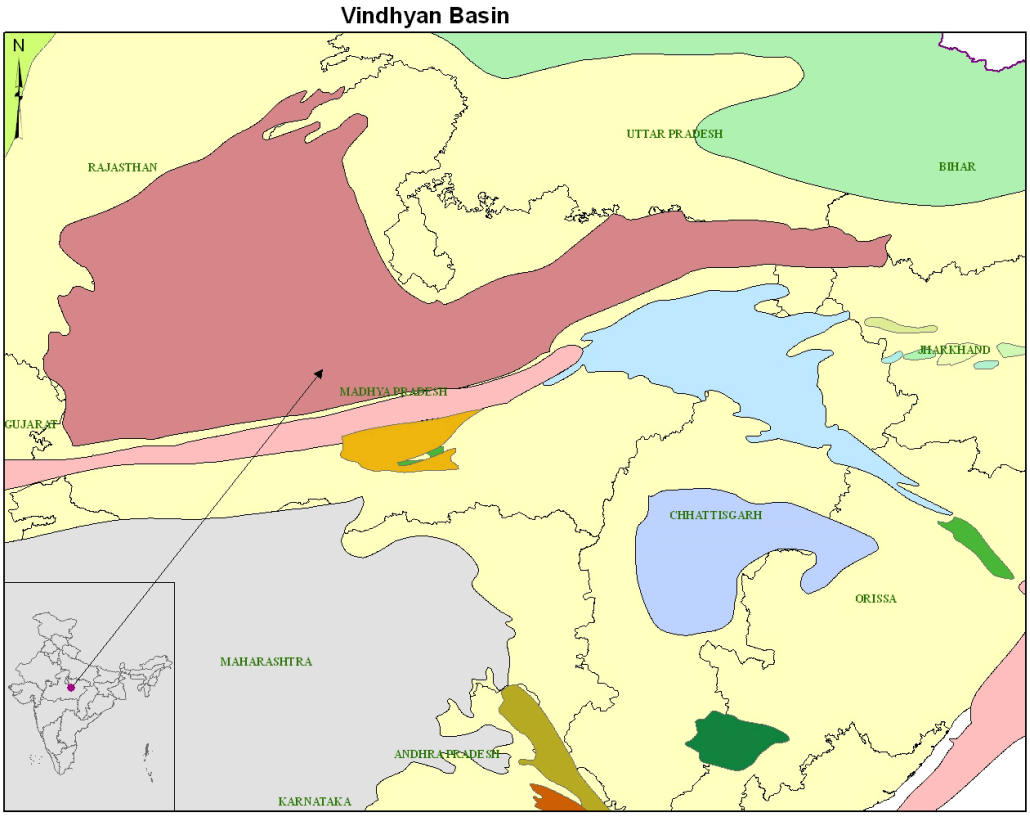
Basin Introduction:

The Vindhyan basin is a classic example of Proterozoic intracontinental basin that developed in the central part of the Indian shield along with several other basins such as Cuddapah, Chattisgarh, etc. The strata are exposed in three major sectors: Son valley, Bundelkhand and Rajasthan. Substantially thick Vindhyan rocks have also been recognized under the Gangetic alluvium.



The Vindhyan Basin, containing more than 5000 m thick sequence of sandstones, shales and limestones, occupies an area of about 1,62,000 sq.km of which about 80,000 Sq.km extends into the Ganga valley in the north and northeast beneath the Tertiary sediment of the Himalayan foredeep. In the southwest, the Vindhyan rocks are covered by Deccan volcanics.

Tectonic Framework:

The basin is bounded by the Son-Narmada Geofracture in the south, the Great Boundary Fault in the west, the Monghyr-Saharsa Ridge in the east, and the Bundelkhand Massif and Indo-Gangetic Plains in the north. Bundelkhand Massif divides this basin into two parts – the Son Valley on the southeastern side and the Chambal Valley where exposures occur from Agra (Uttar Pradesh) to Chittorgarh (Rajasthan).

The southern margin of the Vindhyan basin is marked by a major ENE–WSW trending

lineament termed Narmada–Son lineament south of which occurs the Satpura orogen. A NE–SW trending major lineament known as Great Boundary Fault separating the Aravalli–Delhi orogen from the Vindhyan, also marks the western margin of the Vindhyan basin in the Rajasthan sector.

The Vindhyan strata define a broad, regional syncline trending ENE–WSW. The axis of the syncline is slightly curved and plunges gently towards west. The average dip of the southern limb is greater than that of the northern limb rendering the axial plane to dip southerly.

Basin Evolution:

The Vindhyan Basin was formed as a result of a large crustal downwarp in the northern part of the Indian Platform, after the Delhi orogeny. The initial transgression of the sea from the north is inferred to have taken place in the eastern part of the basin over the Bijawars. The shallow sea appears to have established lagoonal conditions near the coastal part during the subsequent regressive phase. Initially, the Son-Narmada Lineament was dormant, but at the onset of Vindhyan sedimentation later, the fault system along this downwarp became active with the formation of the southern limit of Vindhyan deposition.

After the deposition of Kajrahat Limestone, the Son-Narmada Lineament again became active resulting in emission of volcanic material, which was deposited as the Jardepahar Porcellanite. In the subsequent regression, the shore line shifted towards northwest. The Fawn Limestone was deposited over the shelf in a tidal flat environment. This was followed by shallowing of the basin as is evident from the overlying Glauconitic Sandstone. The fresh marine transgression resulted in the deposition of marine shales followed by Rohtas Limestone.

Stratigraphy:

The entire Vindhyan succession, maximum thickness estimated to be around 3 km, and comprising mainly sandstone, shale and limestone is assigned as the Vindhyan Supergroup. The Supergroup is divisible into four groups:

- Semri Group,
- Kaimur Group,
- Rewa Group and
- Bhander Group,

from bottom to top. Each group is again subdivided into several formations. The Semri Group in the Son valley rests unconformably on a variety of pre-Vindhyan rocks such as granites and metamorphics. In the Bundelkhand area, the group overlies the Bundelkand Granite Gneisses and Bijawar Group of metamorphics, whereas in the southern Son valley, Mahakoshal is the basement in most places; however, in some localities (e.g., Deoland, M.P.) the basement is granite. The Semri succession of the Bundelkhand area has two detached outcrops around Chitrakut and Bijawar respectively, and is only a few tens of meters thick.

The different depositional systems recognized in the Vindhyan succession are: alluvial fan, fan delta, braid delta, braidplain, eolian sand sheet, tidal flat (carbonate as well as siliciclastic), shoreface (tide and storm dominated), storm dominated shelf, homoclinal carbonate ramp, distally steepened carbonate ramp and epeiric peritidal flat (siliciclastic). The overall paleocurrent directions of the depositional systems in the Son valley are northerly suggesting a source towards south. The unconformities divide the Vindhyan succession of Son valley into five sequences. Each sequence consists of several systems tracts representing different paleogeographic settings and marking paleogeographic shifts. The different strata of the Vindhyan succession show evidences of soft-sediment deformation suggesting synsedimentary tectonic activity. The progressive and successive angular unconformities suggest that the deformation pattern shown by the Vindhyan strata is a reflection of synsedimentary tectonic activity. It is postulated that the individual sequences of the Vindhyan succession are related to discrete episodes of tectonism that induced the subsidence necessary for accumulation of sediments and resulted into deformation of the older strata. Angular unconformities resulted due to erosion of the uplifted crest of the anticlines on which the next sequence of strata was deposited with an angular discordance. There are sediment packages at the northern part of the Vindhyan basin developed from a northerly source and thus representing different tracts and sequences from those of the southern part. These packages are represented intermittently in the succession and have been interpreted as representing periods of uplift of the Bundelkhand Granite and subsequent erosion in the north. The paleocurrents revealed by the Vindhyan strata are typically northerly suggesting that the evolving Satpura orogen served as the source for the Vindhyan sediments. However, the source for the clastics occurring within the Semri and the lower parts of the Kaimur and Rewa Groups in the Bundelkhand sector was perhaps the Bundelkhand Granite Gneiss, Bijawar and Gwalior Group of rocks as manifested by the southerly paleocurrent.

Petroleum System:.

Source Rocks

SOURCE ROCKS Lower Vindhyan shales, particularly, Hinota and Pulkova shales with organic carbon contents of upto 3.89% and 1.86% respectively are considered to be having

good potential as source rocks.

Reservoir Develpoment

Sandstones and limestones of Lower Vindhyan and Upper Vindhyan sequences are potential reservoir rocks.

Entrapment

In the central part of the basin, there exist a number of step faults around the southeastern margin of the Bundelkhand Massif involving thick sedimentary column. It is envisaged that these faults have created favourable trapping conditions for hydrocarbon accumulations. There are many structural features like the Jabera dome in the Son Valley and a number of anticlines near Chittorgarh in the Chambal valley. Furthermore, fault controlled traps are envisaged along the basin margin. Updip truncations against regional unconformities may also constitute hydrocarbon plays.

Exploration Status:.

GSI mapped 23,690 sq km area, 400 core samples and 1360 rock samples analysed for source rock potential. ONGC acquired Gravity-Magnetic data at 11464 stations. NGRI also conducted DSS (Deep Seismic Sounding) survey from Hirapur over Bundelkhand Massif to Mandla, south of Jabalpur. Aeromagnetic survey to the tune of 59,771 LKM have also been carried out in this basin.

CDP reflection survey covering 6802 LKM has been conducted by ONGC. Further, DGH and Alphageo (India) Limited carried out CDP vibroseis reflection survey amounting to 566 LKM. Aeromagnetic survey to the tune of 59,771 LKM have also been carried out in this basin.

Exploratory Drilling

Three exploratory wells namely, Jabera-1, Damoh-1 and Kharkhari-1 have been drilled in this basin. The well Jabera-1 has been drilled to a depth of 3597.70 m. The well Damoh-1 has been drilled to a depth of 3501 m. However, no indications of hydrocarbon were obtained.

HC Potential:.

Surface gas shows in the northeastern part of Jabera and numerous gas shows observed during drilling and testing of well Jabera-1, suggest that hydrocarbons have been generated in this basin. Presence of suitable reservoir rocks in Vindhyan sediments and several structural and stratigraphic traps make the hydrocarbon prospects of Vindhyan Basin as moderate to good.

Expected Play Types

The principal exploration targets in this basin are:-

- Large structural closures
- Unconformity controlled traps (updip truncations against regional unconformities)
- Wedgeouts and pinchouts
- Fractured basement in juxtaposition with source rock