

## **Integrated geochemical and mineralogical studies of Cretaceous Formations from Meting-1 Well, Kirthar Foreland Belt, Sindh, Pakistan**

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### **Abstract**

Petrographic, geochemical and mineralogical studies were carried out on ditch cutting samples from exploration well Meting-1, Kirthar Foreland Belt, Sindh, Pakistan. From Eocene to Jurassic rocks were encountered this well. Only fine grained closely spaced rock samples from the Cretaceous Goru, Sembar and the Jurassic Chilton were studied in detail. The study was aimed to investigate the unconventional hydrocarbon source and reservoir prospect in relation to organic matter type, its maturity and mineralogy of the upper sand, upper shale, middle sand, lower shale, upper basal Talhar shale sand, Talhar shale, lower basal sand of the early Cretaceous Lower Goru and Sembar formations. These included the facies analysis which is based on forty four (44) well cuttings samples from a depth of 2360-4280m. Vitrinite reflectance of the lower Goru formation ranges in maturity values from 0.86% to 1.1%, representing fine grained organic matter. Rock-Eval pyrolysis indicates that the Kerogen type III is present in all the samples which mainly generates gas. The average S1 values are <0.5mg HC/g rock while S2 are >0.5mg HC/g rock, The quality of hydrocarbon falls in nonproducing zone keeping in view HI 82.54mgHC/g and S1/S2 ratio 0.37. Sediments of Lower Goru Formation are thermally immature in this well. Total Organic Carbon (TOC) from middle sand (2267-2360m) of Lower Goru Formation ranges from 0.51- 0.7% showing poor to slightly fair potential, while the TOC of the lower shale (2360-2390m) has descending order values ranging from 0.86-0.25% reflecting fair potential in its upper part. The upper basal Talhar Shale sand (3000-3260m) has good value of 2.56% TOC and this value shows its extent in Talhar shale (3280-3360m) with 2.44% TOC. Lower basal sand unit (3360-3554m) of the Lower Goru Formation has 1.53-0.55% TOC indicating fair potential. The TOC of Sembar Formation is 0.57-1.43% showing good potential. Rock-Eval pyrolysis indicates that the Kerogen type IV is present. The average S1 values are 0-0.5mg HC/g rock while S2 are <0.5mg HC/g rock. The quality of hydrocarbon falls in nonproducing zone keeping in view HI 24mgHC/g and S1/S2 ratio of 0.07. Sediments of Sembar Formation are thermally immature as Tmax ranges from 372-418 C in this well. Detailed petrographic and XRD studies reveal that all the samples are predominantly composed of quartz and carbonates (mainly calcite) with subordinate feldspars (plagioclase and microcline varieties) as detrital matrix/ cement in all the samples. Chlorite is also present but in subordinate amounts as detrital grains as well as matrix/cementing material. Calcareous bioclasts are common in the sandstone. Black to brownish carbonaceous matter is present in most of the samples in variable amounts. The sandstones and siltstones are compositionally immature and commonly display a polymodal composition. The siltstone and sandstones are well cemented and the pore spaces are filled with lime mud/clayey matrix (clay is used as size term referring to fine particles <1/256 mm in diameter throughout the text). The rocks display a wide variation of grain packing marked by floating grains in the matrix-supported sandy limestone to sutured to stylolitic planoconvex to tangential to point contacts. The most common porosity types are fractured, matrix, micro and inter-granular with an average value of less than 1%. Organic /carbonaceous residual matter occurs as disseminated particles at several stratigraphic intervals. The presence of clayey/lime mud matrix, neomorphic spar cement, close packing with sutured contacts, stylolites with iron oxide/ clay are the main porosity reducing factors in the Lower Goru Formation.