Attempting to Quantify Subsurface Uncertainties with Dynamic Data - a Reservoir Management Case Study

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Abstract

Analyses of dynamic data that include pressure and production history have long been recognized as a tool to evaluate the underground reservoir size, fluid volumes and future performance. This study encompasses a similar case utilizing analytical and numerical methods to interpret the dynamic data. As a result several geological features were confirmed and a few sub-seismic features were identified.

The field is located in Lower Indus Basin of Pakistan and characterized by hydrocarbon accumulations in Lower-Goru Upper-Sand reservoirs. Exploratory well A-1 discovered the field by finding A-Sand which was believed to be dry gas reservoir based on formation evaluation and open-hole log profile. The structure was bounded by two major intersecting faults and one splay fault, all juxtaposed against shale barriers. Due to these structural features A-Sand was expected to exhibit depletion drive mechanism.

Conforming to behaviour typical of dry gas, A-1 initially tested 20 MMscfd at CGR of 5 stb/MMscf. Without following any plateau period gas rates started declining with increasing CGR. After eight months well was producing 1 MMcfd at CGR of 200 stb/MMscf. Routine surveillance showed depletion in reservoir pressure from 1800 to 380 psia. Due to these two factors and gradual increase in water production well loaded up after a year

The well was then revived on Gas Lift and it now became essentially an oil producer with a GOR of 2000 scf/stb. Oil analysis showed change in API from initial value of 62 to 44. Throughout Gas Lift stage, A-1 produced at fairly stable liquid rates of

30-50 bopd at 70% water cut and at GOR of 800 scf/stb. BHP surveys showed no further depletion than 400 psia. These facts hinted at pressure support to A Sand reservoir as opposed to originally assumed closed structure.

To boost oil production, hydraulic jet pump - suitable for GOR lower than 1000 scf/stb - was installed and achieved apex oil rates of 500 bopd, interestingly, without commensurate increase in water production. To identify source of A-Sand recharging, it was decided to re-study the structure of the field by 1) developing Allen diagram 2) reviewing FMI (Full bore Magnetic Imaging) logs to re-calibrate fault position and 3) re-interpret pressure build-up data with numerical Models by integrating G&G data.

The study concluded that Splay fault on reservoir structure may not be completely sealing for two reasons: 1) Allen Diagram suggested throw of the splay fault decreasing northwards intimating possibility of juxtaposition with down-thrown A-Sand. 2) Numerical Model of pressure

survey data matched with slightly different position of faults. This way, the works emphasized the role of dynamic data in adding value to a company's knowledge of sub surface elements and hence widen the scope of field development strategy.