ABSHERON: STRUCTURE AND STRATIGRAPHY OF A DEEP WATER PROSPECT

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The Absheron prospect is a large anticline in Neogene clastic sediments of the southern Caspian Sea, about 30 km southwest of the giant Guneshli-Chirag-Azeri fields of Azerbaijan. Water depths vary from 220 to 640 meters over the license area. Located between a deep basin of probable source rocks and several billion barrels of proven oil reserves, it is ideally situated for trapping migrating hydrocarbons. One of the first deep-water prospects to be leased by the Azerbaijan government, the exploration efforts at Absheron are being undertaken by Chevron (operator), SOCAR, and Total.

Our exploration of this block began with regional studies using 1980s and early 1990s limited-offset seismic lines and well logs. Specialized seismic processing and interpretation of these and more recent 2-D seismic data have confirmed the structure and have identified possible shallow gas zones and a shallow zone of gas hydrates. Velocity anisotropy measurements show that horizontal velocities in shallow sediments are significantly faster than vertical. Subsequent 3-D seismic data acquisition, interpreted in conjunction with wells tied to 1995 2-D seismic lines, provides us with higher-resolution data to refine our seismic facies interpretations and map depositional environments. Interpretation of faults, channels, and other discontinuities is further enhanced by the use of special 3-D visualization techniques such as Chevron's proprietary EDGE processing.

Structure

The Absheron structure has formed above a north-dipping thrust fault at roughly 7 seconds 2-way reflection time, corresponding to a depth of about 11 km. Within the anticlinal fold, we find several en echelon northeast-trending normal faults caused by extension of the middle and upper sedimentary layers above the basal compression. The structure began forming in Upper Surakhany time and continues to grow to this day. Seismic horizons between the Middle Surakhany (structural crest about 3000 m depth) and the Kalin Suite (structural crest about 7800 m) are conformable. The horizons have structural closure of 100-300 sq km, with the closure area decreasing with depth. Structural closure of post-Surakhany sediments moves to the west and the relief decreases with shallowing depth, and there is no structural closure at the sea floor and shallowest horizons.

The seismic expression of the eastern part of the structure is severely deformed by an active mud volcano. Abundant gas in the uppermost mud of this volcano (adjacent to the sea floor) absorbs or reflects all seismic energy, so we have been unable to identify the stratigraphic interval from which the mud originates. Paleontologic analysis of a core from the summit of the mud volcano suggests that the mud comes from below the Productive Series. To the north of the mud volcano, Holocene sediments have been faulted by large gravity-slide listric normal fault systems. South of the mud volcano, we have identified a shallow zone with thick accumulations of high-velocity sediments, interpreted to be gas hydrates. The exploration drilling program will be designed to handle gas release from hydrates while penetrating this part of the section. Other possible drilling hazards within the block include two accumulations of shallow gas at the post-

Absheron-Formation horizon, 800-900 meters below sea level that is the base of the gravity slides discussed above. One of these is to the west of the structural crest of the deeper Productive Series reservoir targets, in a manifestation of the eastward migration of the structural crest with depth. The other gas accumulation is to the east of the mud volcano and appears to be trapped against it. Because of the shallow depth, these gas accumulations are not economically significant, but their low velocities distort and attenuate the seismic data, creating time sags in the deeper horizons.

Stratigraphy

Beginning with our initial study of 2-D seismic lines and well logs, and continuing with the more recent 2-D and 3-D data, we have correlated depositional sequences from the Absheron Peninsula and Sill to the deep Caspian Basin in the south, and west into the Kura Valley. Potential reservoir facies within the Productive Series are inferred to have been deposited in fluvial, paralic, and slope environments. Assessment of depositional systems, at a sequence level, was deduced from stacking patterns and gamma-ray character in wireline logs from several fields within 60 km of the Absheron structure. Key fields among these included Bahar and Shah Deniz in the west, Janub and Guneshli in the north, and Kyapaz in the east. Extension of the inferred depositional system(s) at these well sites onto the structure was accomplished by evaluating the aerial extent of seismic facies.

In general, the Upper Productive Series adjacent to the Absheron Structure is characterized by a deepening or long-term (i.e., second-order) transgression from the Fasila (formerly Pereriva) to the top of the Productive Series. The lowermost suites (Balakhany to Upper Sabunchy) are dominated by fluvial channel sands typical of an upper delta plain setting. Throughout the middle suites (Upper Sabunchy through the Middle Surakhany), the most common depositional environment within the individual sequences changes upward from lower delta plain to inter-deltaic to delta front and pro-delta. In addition, variations within each of the sequences document rapid facies changes as the coastal systems responded to fluctuating accommodation space. Finally, during the Upper Surakhany, turbidites shed from the Absheron Sill were deposited on delta-front and slope settings and are inferred to be the principal reservoir type. The 'delta-dominated' successions in the lower and middle parts of the Productive Series consist of relatively parallel seismic horizons. The uppermost succession dominated by turbidite deposits, however, is characterized by seismic reflections that onlap the growing structure.

Conclusions

Our exploration targets are therefore Productive Series sands in a large depth range. Source rocks are inferred to be the same as those sourcing the Absheron Sill oil and gas fields, and are interpreted to lie to the south and southwest of the prospect. We rely on recent migration of hydrocarbons to fill the prospect, after the structure formed in the Late Pliocene.