SEDIMENTOLOGICAL RESPONSE TO CLIMATE CYCLES DURING THE PLIOCENE OF THE SOUTH CASPIAN BASIN

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Sedimentological and paleontological studies of outcrops within the Paleo-Volga province of the Productive Series in the Kirmaku Valley north of Baku, Azerbaijan reveal a distinctive cyclicity inferred to record 40-ky cycles in lake level and climate of the Caspian basin. The pattern is consistent with inferences made from core and log data obtained in offshore oil fields on the Apsheron Sill farther to the southeast.

Typical sequences range from 20 to 40 m in thickness and are bounded by erosional surfaces at the base of thick sandstones and/or surfaces recording subaerial exposure within mudstones. These surfaces are interpreted as sequence boundaries (SB) representing periods of subaerial exposure along the margins of the Caspian Sea.

The succession immediately above the sequence boundary differs between proximal and distal locations in the depositional system. In proximal settings, the sequence boundary is erosional and abruptly overlain by cross-bedded sandstone. Shale clasts are common at the base and locally those are the only indicators of prior mud deposition. In distal settings, the exposure surface is generally overlain by a coarsening-upward succession of interbedded sand- and mud-stone, commonly horizontally or ripple-laminated, which may grade upward into thick, cross-bedded sandstones. The sandstone package is inferred to represent a lowstand systems tract (LST) that accumulated during a phase of slow rise in lake level. The proximal LST consists of braided fluvial deposits above a deeply-incised SB, whereas the distal LST consists of relatively thin fluvial distributary mouthbars and crevasse-splays overlain by distributary channels.

The sandstones are overlain by dark, clay-rich mudstones or interbedded thin sandstones and mudstones. Typically, the mudstone interval first fines then coarsens upward on a scale of about 10 m. Ostracods in the mudstones indicate a trend of water deepening followed by shallowing towards the next, overlying sandstone, attaining perhaps a maximum water depth of about 50 m. Mud deposition is inferred to occur during rapid lake level rise, highstand and fall. During rapid rise the distal deltas drown and shift rapidly landward, forming the fining-upward succession of a transgressive systems tract (TST). During highstand, the deltas were typically far to the north of the Kirmaku Valley and only distal prodelta mudstones accumulated in the study area. Since there is no sandstone between the TST/HST muds and the next overlying exposure surface, the implication is that lake level fall was not associated with progradation and return of deltaic systems into the region. The falling stage systems tract (FSST), therefore, consists of thin mudstones or nothing at all, implying that rivers essentially dried out during periods of lake level fall.

The number of Pliocene sequences recorded is consistent with an average duration of about 40-ky per sequence. The global □O16 curve for the Pliocene demonstrates a strong 40-ky (obliquity) climate cycle. Therefore, we infer that the sedimentation pattern just described record a climate pattern of dry, hot periods characterized by Caspian lowstands, alternating every 40-thousand years with episodes of cool, wet highstands. Sand entered the region of the Kirmaku Valley only during intervals of slow lake level rise following absolute lowstand. Palynological data appear to support the inference that the lower part of the mudstone interval (TST/HST) records a trend of cooling and increasingly humid climate, whereas the upper mudstone interval (FSST) records a return to hot and arid conditions.