

Paleoenvironments, palynological events, and subsurface correlation of the Sarah Formation and Quwarah Member of Qasim Formation in NW Saudi Arabia

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ABSTRACT

The Upper Ordovician Sarah Formation (Hirnantian) and Quwarah Member, Qasim Formation (Katian), are actively explored for hydrocarbons in NW Saudi Arabia. They represent genetically differentiated siliciclastic units in a continental shelf setting. The Quwarah Member comprises fine to medium-grained, laterally continuous sedimentary successions deposited on a low-relief shelf subjected to wide-amplitude sea-level fluctuations. The Sarah Formation is lithologically and geometrically more heterogeneous, comprising coarse to fine-grained sandstones, mudstones and shales organized in laterally and vertically variable sedimentary bodies controlled by subglacial erosion linked to advances and retreats of the Late Ordovician icecap. The Sarah/Quwarah contact is characterized by erosional unconformities of highly variable amplitude, depending on the proximity of the contact to the ice-front and position within or outside glacial valleys. Palynological analyses of these units resulted in a refined palynozonation and definition of a series of First Downhole Occurrences (FDO), which help recognize stratigraphic boundaries, intra- Quwarah biostratigraphic subdivisions, and high-resolution correlation of stratigraphic horizons within this unit. The Sarah Formation is characterized by the co-occurrence of the acritarchs *Villosacapsula setosapellicula* and *Veryhachium subglobosum*, together with the common occurrence of Qasim-sourced reworked palynomorphs, demonstrating substantial glacial-related erosional processes. No consistent intra-Sarah palynozonation is currently available. At the Sarah/Quwarah boundary, the FDO of abundant chitinozoan *Armoricochitina nigerica* is observed followed by the successive FDOs of *Acanthochitina cf. barbata*, *Calpichitina bernardae*, “*Haplochitina*” sp. P, *Belonechitina* sp. K, and *Tanuchitina fistulosa*. This subdivision significantly improves the palynostratigraphic resolution in the Katian of NW Saudi Arabia, facilitates correlation of reservoir-quality sandstone bodies within the Quwarah Member, and can be used to estimate the magnitude of glacial erosion occurring at the Sarah/Quwarah boundary. The palynological events can also assist in sequence-stratigraphic interpretations. The FDO of *C. bernardae* corresponds to an intra-Quwarah regional marine flooding surface, and the FDO of *T. fistulosa* coincides with a significant surface (sequence boundary?) separating mudstones of the Ra’an Member below, from the lowermost Quwarah sandstones above.