

Palynological Characterization of Cambro-Ordovician Successions in Saudi Arabia and Oman: Chronostratigraphic and Paleoenvironmental Significance

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Abstract

Cambro-Ordovician successions of Saudi Arabia include the fluvial to marginal marine Saq Formation (upper Cambrian to lower Middle Ordovician), the marine Qasim Formation (upper Middle to Upper Ordovician) and the glaciogenic Sarah Formation (Hirnantian, uppermost Ordovician). The objective of this study is to review the palynostratigraphy of the Saq and lower Qasim stratigraphic sections.

The Saq Formation is subdivided into the Risha Member (Upper Cambrian) and the Sajir Member (Lower to Middle Ordovician). Palynological constraints on the age of the Risha Member are provided by the CB1 Palynozone of Late Cambrian assemblage (e.g., *Trunculumarium revinium*, *Timofeevia phosphoritica* and *Ninadiacrodium dumontii*, among others). This is a typical assemblage occurring worldwide in Furongian-aged strata and indicates an episode of open marine facies within the predominantly fluvial to marginal marine lower Saq Formation. In Oman, similar assemblages occur in the Al Bashair Formation of the Andam Group. In the lower part of the Sajir Member, the occurrence of *Acanthodiacrodium angustum* and *Vulcanisphaera* spp. (O6 Palynozone) suggests an earliest Ordovician (Tremadocian) age and correlation with the Barakat and Mabrouk formations of the Andam Group of Oman.

An impoverished acritarch assemblage characterized by *Coryphidium bohemicum*, *Aureotesta clathrata*, *Barakella* spp., *Striatotheca* spp. occurs sparsely in limited localities from the Sajir Member in eastern Saudi Arabia (O5/O6 Palynozone). Its age is certainly post-Tremadocian, most probably Floian and shows similarities with assemblages described from the uppermost Ghudun Formation of Oman, interpreted as late Floian to early Dapingian in age.

Mud-rich, bioturbated deposits at the top of the Sajir Member are palynologically dominated by monad sporomorphs (e.g., *Virgatasporites* spp., various hilate sporomorphs) and characteristic acritarch species such as *?Clypeolus* sp., *?Cymatiosphaera* sp., *?Retialetes* sp., and *Barakella* spp. The first occurrence of some typical Middle Ordovician acritarch taxa such as *Arkonina*, *Striatotheca*, and *Frankea*, and the chitinozoan *Siphonochitina formosa* are also typically represented (O5 Palynozone). The age of this assemblage spans the Dapingian to earliest Darriwilian, confirmed by macrofossils, and indicates a marginal marine, restricted paleoenvironment. Seemingly similar palynological assemblages occur in Oman in the lowermost part of the Saih Nihayda Formation of the Safiq Group.

Stratigraphically above the Sajir Member of the Saq Formation, the basal Qasim Formation is represented by predominantly transgressive shale deposits of the Hanadir Member which yield highly diverse and well preserved mixed acritarch and chitinozoan assemblages typical of Darriwilian age (Middle Ordovician) which include key taxa such as *Frankea* spp., *Dicrodiacrodium* spp., *Stellechinatum* spp., *Linochitina*

pissotensis, *Laufeldochitina clavate* (O4 Palynozone). In Oman, such assemblages have been described from the upper, shaly part of the Saih Nihayda Formation. Interestingly, these Darriwilian deposits also contain rich spore assemblages (tetrads and dyads) which represent the oldest recorded occurrence of cryptospores with unambiguous affinities to early embryophytes, true land plants.