

4. Hrvatski geološki kongres
s međunarodnim sudjelovanjem
4. Croatian Geological Congress
with international participation

Šibenik 14.–15.10.2010.

Knjiga sažetaka Abstracts Book



Urednica – Editor:
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Hrvatski geološki institut – Croatian Geological Survey
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ZAGREB, 2010

Paleozoic and Mesozoic succession of sediments in Al Bahra-1 well (Syria)

Paleozojsko-mezozojski slijed naslaga u bušotini Al Bahra-1 (Sirija)

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Ključne riječi: silur, karbon, perm, trijas, kreda, litostratigrafske formacije

Key words: Silurian, Carboniferous, Permian, Triassic, Cretaceous, Lithostratigraphic Formations

The vertical exploration well Al Bahra-1 is located in the Hayan block in Syria. It has penetrated 4147 m of sediments ranging from the Upper Cretaceous to the Silurian.

The succession of sediments began with the Markada Formation (4147–3165 m) of the Palaeozoic, identified at the bottom of the well. Sediments are composed of shale (in places sandy) with a lot of opaque materials (probably magnetite) and lenses of siltstone and quartzarenite. The Early Carboniferous age is confirmed on the basis of palynofloristic sporomorph composition (*Cingulizonates* sp., *Vallatisporites* sp. div., *Spelacotriletes* sp. div., *Raistrickia* sp.). Sedimentation probably took place in *continental*-marine *transitional* paleoenvironments, as lacustrine-swamp to tidal flat sediments, with some fluvial influence.

The Tanf Formation (3165–3120 m) of the Silurian, consisted of shale, sandy shale and opaque material (probably magnetite) seemed to be brought into abnormal contact with the Carboniferous sediments beneath. The Carboniferous deposits occurred below and above the Silurian deposits, therefore reverse faulting should be taken into consideration. According to the palynofloristic assemblage (MOLYNEUX et al., 1996) represented by *Multiplicisphaeridium* sp. div., *Evittia* sp. div., *Cymbosphaeridium* sp. div., *Lophosphaeridium* sp. div. and *Veryhachium* sp. div., the sediments are dated as Silurian in age. Lithology and palynofacies characteristics indicate deposition in relatively proximal marine shelf environment with some fluvial influence.

The Markada Formation (3120–1060 m) of the Palaeozoic follows. The deepest part of this interval (3120–2415 m) is consisted of claystone/shale with opaque materials (probably magnetite), as well as lenses and laminae of bioclastic limestone (W/P), biomicrite (W), crystalline dolomite with anhydrite and gypsum, siltstone, quartzarenite and litharenite. The next interval (2415–1610 m) is made of mudstone/shale in places sandy and conglomeratic, rarely altered to greywacke, with lenses or laminae of quartzarenite to subarkose, siltstone,

claystone and seldom aphanitic to crystalline dolomite. The series ends with the hematitic mudstone/shale (in some places sandy and conglomeratic or turn into the greywacke) and sporadically with quartzarenite of the last interval (1610–1060 m). Carboniferous age has been defined by very rich fossil assemblages. The most significant microfossils are: *Ammarchaediscus explanatus* VDOVENKO, *Omphalotis omphalota* (RAUSER-CHERNOUSSOVA & REITLINGER), *Planoendothyra spirilliformis* (BRAZHNIKOVA & POTIEVSKA), *Endothyra* cf. *similis* (RAUSER-CHERNOUSSOVA & REITLINGER), *Pseudoammodiscus parvus* (REITLINGER), *Pseudoammodiscus* sp., “*Endothyra*” ex gr. *bowmani* PHILLIPS, *Endothyra* sp., *Omphalotis*? sp., *Tetrataxis* sp. and Bryozoa. Also, numerous sporomorph assemblage (OWENS, 1996) are determined: *Calamospora* sp. div., *Leiotriletes* sp., *Punctatisporites* sp. div., *Punctatosporites* sp., *Retusotriletes* sp., *Lophotriletes* sp., *Anaplanisporites* sp. div., *Acanthotriletes* sp., *Spelaeotriletes* sp., *Verrucosisporites* sp., *Convolutisporites* sp., *Reticulatisporites* sp., *Raistrickia grovens*, *Lycospora* sp., *Densosporites* sp., *Cingulizonates* sp., *Vallatisporites* sp. div., *Vallatisporites* cf. *pusillites*, *Vallatisporites verrucosus* and *Vallatisporites vallatus*. Sediments most probably originated in the transitional (deltaic) environment with occasional short marine episodes (perireef).

The Palaeozoic Amanus Sand Formation and the Mesozoic Amanus Shale Formation follow. In this interval (1060–790 m) quartzarenite (in places with characteristic of sublitharenite, or subarkoze), litharenite, shale and tuff are defined. Since there are no relevant microfossils, and palynomorphs are rare and poorly preserved (?*Endosporites* sp., ?*Densosporites* sp., ?*Cyclotriletes* sp., ?*Veryhachium* sp.), the Permian to Scythian age is just supposed on the basis of correlation with previous investigated wells, EK logs and lithology. Depositional environment was most probably transitional to continental.

Next is the Kurrachine Dolomite Formation of the Middle Triassic (790–570 m) composed of dolomite (very finely to medium, sporadically coarsely, crystalline), in places sandy and recrystallized dolomicrite (aphanocrystalline to very finely crystalline dolomite) and sporadically volcanoclastic (?) breccia and shale. Microfossil association is very poor or almost absent. Sporomorphs are abundant: *Punctatisporites* sp., *Todisporites* sp. div., *Heliosaccus dimorphus*, *Cannanapollis scheuringii*, *Vitreisporites pallidus*, *Brachysaccus neomundanus*, *Brachysaccus ovalis*, *Sulcatissporites kraeuseli*, *Alisporites* sp. div., *Falcisporites* sp. div., *Platysaccus queenlandiae*, *Minutosaccus crenulatus*, *Samaropollenites speciosus*, *Parillinites* sp., *Angustisulcites* sp., *Voltziaceasporites heteromorpha*, *Triadispora* sp. div., cf. *Stellapollenites thiergartii*, *Lunatisporites acutus*, *Lunatisporites pelucidus*, *Striatoobieites balmei*, *Aulisporites astigmus*. Phytoplankton (*Leiosphaeridia* sp., *Michrystidium* sp. div.) and Chlorophyceae (*Botryococcus* sp.) are represented rarely. Based on the palynofloristic assemblages (730–720 m) the Late Anisian to Early Ladinian age is defined. Lithology and palynofloristic assemblages indicate peritidal – supratidal environment.

The Kurrachine Dolomite (570–311 m) Formation consisted of very finely to coarsely crystalline dolomite with laminae of organic matter and early diagenetic acicular and nodular anhydrite, micrite (M) in places dolomitized, dolomitized ooidic bioclastic limestone (W/P) and claystone to clayshale continues into the Upper Triassic as well (LUČIĆ et al., 2003). Microfossils are rare. Besides fragments of echinoderms, ostracods and thin mollusc shells, together with Middle to Late Triassic benthic foraminifera have been found: *Fronicularia xiphoidea* KRISTAN-TOLLMANN, *Fronicularia* sp., *Agathamminoides* sp., *Semiinvolutina* sp. and *Aulotortus* sp. On the basis of the recovered palynofloristic assemblages represented by *Minutosaccus crenulatus*, *Samaropollenites speciosus*, *Patinasporites densus*, *Pseudenzonalasporites summus*, *Froehlichsporites traversei*, *Partiisporites* sp., *Partiisporites verrucosa*, *Duplicisporites* sp., *Camerosporites secatus*, the deposits of the analysed samples are dated more precisely as Carnian in age (YAROSHENKO & BASH IMAM, 1995). Sediments are deposited in supratidal with sabhka environment.

Discordantly follows the Judea Formation of the Upper Cretaceous (311–202 m) composed of dolomite (aphanocrystalline, very finely crystalline and coarsely crystalline

with visible vugy porosity). Only rare undeterminable small benthic foraminifera, thin mollusc shells, gastropods and ostracods have been found. On the basis of correlation with previously investigated wells, EK logs, and lithology the age of whole interval has been estimated as Late Cenomanian – Turonian. Sedimentation took place in the shallow subtidal – supratidal environment.

The Soukhne Formation of the Upper Cretaceous (202–150 m), consisted of fossiliferous marls to calcareous marlstones came after. Both planktonic and benthic foraminifera (*Heterohelix globulosa* (EHRENBERG), *Archaeoglobigerina blowi* PESSAGNO, *Muricohedbergella* sp.) have been identified. On account of recovered microfossil assemblages and EK logs, deposits are dated as Coniacian – Early Campanian in age. Environment of deposition is outer shelf to deep marine.

The Shiranish Formation of The Upper Cretaceous (150–45 m) made of fossiliferous clay marl and fossiliferous marl to calcareous marlstone ends the succession of sediments in Al Bahra-1 well. The microfossil association of rare planktonic foraminifera *Macroglobigerinelloides prairiehillensis* (PESSAGNO), *Muricohedbergella* sp. and *Bulimina* sp. defines Late Campanian to Maastrichtian age. Sedimentation took place in outer shelf to deep marine depositional environment.

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