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Original article

Ordovician chitinozoans and acritarchs from southern and southeastern Turkey

Chitinozoaires et acritarches ordoviciens du sud et du sud-est de la Turquie

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Abstract

Revision of the lithostratigraphy of Ordovician deposits in southern and southeastern Turkey led to a re-evaluation of the age assignments of formations identified in the subsurface and at outcrop. Previous datings were based on macrofauna (mainly trilobites and graptolites). The present paper focuses exclusively on organic-walled microfossils (chitinozoans and acritarchs), which provide numerous chronostratigraphical improvements, especially in successions barren or poor in macrofossils. Close to 200 samples were collected in the Taurus chain (i.e. from Kemer, Seydisehir, Ovacik, Kozan, to Sariz regions in southern Turkey) and in the Border Folds (Mardin and Hakkari regions), usually regarded as part of the Arabian Plate in palaeogeographical reconstructions. Many samples are productive and yield chitinozoans and/or acritarchs of extremely variable preservation, depending on their geographical and geological location. In the Taurus chain, the material is "coalified" and frequently fragmented whereas, in the Border Folds, maturation of the organic matter is much lower and preservation of the microfossils is good to excellent. Several Ordovician chitinozoan biozones (northern Gondwana zonation) as well as diagnostic acritarch assemblages are identified in southern and southeastern Turkey. These Ordovician formations are assigned here to the new global stages of the Ordovician chronostratigraphical scale. The Seydisehir (upper part), Sobova, and Kilgen Lake (lower part) formations are referred to the Darriwilian. The Kilgen Lake (upper part), Sort Tepe, and Bedinan formations are attributed to the Sandbian and to the Katian, and the Halevikdere Formation (glacio-marine part) is assigned to the Hirnantian. Reworking of Early Ordovician acritarchs is documented in pre-glacial and in glacial Late Ordovician deposits. They indicate that active erosive processes occurred during the Middle and Late Ordovician sedimentation. The organic-walled microfossils recorded in the Ordovician of south and southeastern Turkey belong to the northern Gondwana realm. Interestingly however, some Baltoscandian influences are noted in the Border Folds during Early Late Ordovician.

Résumé

Une révision de la lithostratigraphie des dépôts ordoviciens du sud et du sud-est de la Turquie a conduit à une réévaluation des attributions stratigraphiques des diverses formations reconnues, à la fois à l'affleurement et en forage. Des datations étaient déjà fournies par la macrofaune (trilobites et graptolites notamment). Le présent article est consacré exclusivement aux microfossiles organiques (chitinozoaires, acritarches) qui apportent de nombreuses précisions d'ordre chronostratigraphique, notamment dans des séquences pauvres ou dépourvues en macrofossiles. Près de 200 échantillons ont été prélevés dans la chaîne du Taurus (régions de Kemer, Seydisehir, Ovacik, Kozan, Sariz, dans la Turquie méridionale)

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et aux confins sud-est de la Turquie, dans les régions de Mardin et de Hakkari (« Border Folds »), généralement intégrées à la Plaque Arabe dans les reconstitutions paléogéographiques. Beaucoup de ces échantillons se sont révélés fertiles. Ils ont livré des chitinozoaires et/ou des acritarches de conservation très variable en fonction des régions. Le matériel est carbonifié et souvent fragmentaire dans le Taurus. Par contre, la maturation de la matière organique est bien plus faible dans la région de Mardin où la conservation est le plus souvent bonne à excellente. Plusieurs biozones de la zonation des chitinozoaires ordoviciens nord gondwaniens, ainsi que des assemblages d'acritarches significatifs au plan stratigraphique, sont identifiés dans les formations du sud et du sud-est de la Turquie. Celles-ci sont replacées dans la nouvelle échelle globale des étages de la chronostratigraphie ordovicienne. Les formations de Seydisehir (partie supérieure), de Sobova, et de Kilgen Lake (partie inférieure) sont attribuées au Darriwilien. Les formations de Kilgen Lake (partie supérieure), de Sort Tepe et de Bedinan sont rapportées au Sandbien et au Katien. Quant à la Formation de Halevikdere (partie glacio-marine), elle est datée de l'Hirnantien. Des remaniements d'acritarches de l'Ordovicien Inférieur sont notés dans les sédiments pré- et syn-glaciaires à l'Ordovicien Moyen et Supérieur. Ils témoignent d'épisodes d'érosion active durant cette période. Au plan paléobiogéographique, les assemblages de microfossiles organiques observés dans l'Ordovicien de Turquie appartiennent à la Province nord-gondwanienne. Quelques influences balto-scandinaves sont toutefois relevées dans les « Border Folds », notamment au début de l'Ordovicien Supérieur.

Keywords: Chitinozoans; Acritarchs; Ordovician; Turkey (S and SE); Stratigraphy; Palaeogeography

Mots clés : Chitinozoaires ; Acritarches ; Ordovicien ; Turquie (S et SE) ; Stratigraphie ; Paléogéographie

1. Introduction

Lower Palaeozoic sedimentary rocks are fairly widely represented in Turkey (Fig. 1). Many of the formations crop in the central and eastern parts of the Taurus Range belonging to the Anatolian microplate (e.g., Seydisehir, Akyaka, Ovacik, Kozan or Degirmentas areas). Other outcrops are situated in southeastern Turkey, in the Border Folds (e.g., Derik, Mardin, Sort Tepe, and Zab areas) where Lower Palaeozoic strata are also known in the subsurface. The Border Folds region is regarded as the northern part of the Arabian plate (Monod et al., 2003). Macrofaunas (trilobites, brachiopods, graptolites) have been described from the outcrops (Dean, 1967; Dean and Monod, 1990; Dean et al., 1999, and references therein). Early Darriwilian conodonts are also reported (Sarmiento et al., 1999). However, these fauna are frequently concentrated in restricted horizons, and thus large intervals remained poorly dated.

Palynological investigations on Lower Palaeozoic deposits from Turkey are fairly rare. They deal principally with the less mature organic-walled microfossils recorded in the Border Folds area where rich and well preserved Late Ordovician acritarchs, sporomorphs, and chitinozoans have been reported from the "Bedinan Group" s.l. (Erkmen, 1979; Miller and Bozdogan, 1989; Steemans et al., 1996). Other palynomorph assemblages are known from the Late Silurian-Early Devonian Dadas and Hazro formations (Fontaine et al., 1980; Steemans et al., 1996; Brocke et al., 2004). Preliminary data on the more mature and less well-preserved palynological material are also available from the central and eastern Taurus Range (Dean and Martin, 1992; Dean et al., 1993; Monod et al., 2003; Paris et al., 2004).

2. Samples and localities

In recent years, a reappraisal of the regional lithological and biostratigraphical data has been made through extensive field investigations carried out by some of us (O.M, H.K., W.T.D, J.-F. G), with particular emphasis being devoted to the Hirnantian glacial related deposits (Ghienne et al., 2001; Monod et al., 2003). All these new data provide a more robust framework for the palynological investigations being developed to complete, and/or to improve the chronostratigraphical information available on the recorded formations.

The sampling for palynological studies was made during several fieldwork seasons. A total of 122 samples from outcrops (82 samples from eastern Taurus and Border Folds) and subsurface (41 cutting samples from the Border Folds) have been investigated for chitinozoans (Figs. 2–10a,b); 96 are productive when poor fragmentary material recovered from some of the Taurus samples is taken into account. Concerning the acritarchs, 52 outcrop samples and 41 cutting samples (the same as for the chitinozoans) have been investigated. In addition, previous data from 11 core samples from four boreholes in the Diyabakir region (Border Folds, Fig. 1) are updated and included in the biostratigraphic discussion (Figs. 5 and 10a,b).

The present investigations focus on chitinozoans (Plates 1–4) and acritarches (Plate 5) from the Seydisehir (upper part), Sobova, Kilgen Lake, Bedinan, Sort Tepe, and Halevikdere formations. The Seydisehir Formation is composed of alternating quartzites, siltstones and shales ranging from the Upper Cambrian to Lower Ordovician (Dean and Monod, 1990; Dean et al., 1999). In the Beysehir-Seydisehir area the Seydisehir Formation is overlain by the Sobova Formation, which consists of a basal limestone member containing cystoids and a rich trilobitic fauna (Upper Arenig, Dean, 1973), followed by reddish to dark siltstones of Darriwilian age (see below) (Figs. 3 and 4). North of Adana (Kozan area), the Kilgen Lake Formation (informal name) corresponds to dark-grey mudstones and siltstones resting also on cystoid-bearing limestones (Fig. 3). The Kilgen Lake Formation ranges from the Late Darriwilian to Early Late Ordovician (see below). In the Border Folds, although cropping out separately, the Bedinan Formation (Caradoc, Dean, 1967, 1983) and the younger Sort Tepe Formation (early Ashgill, Dean and Zhou, 1988) composed of dark green silty shales and siltstones may be regarded as part of a more comprehensive detrital unit (Dean et al., 1981), which is referred to a "Bedinan Group", a term used here for the subsurface cutting samples as no detailed lithostratigraphical information is available. The uppermost Ordovician Halevikdere Formation corresponds