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Dinoflagellate cysts from the Upper Triassic (Rhaetian) strata of the Tabas Block, East - Central Iran

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Abstract

Rhaetian strata from the Nayband Formation of the Tabas block, East- Central Iran, were studied palynologically. The material examined contained moderately diverse and well-preserved dinoflagellate cyst assemblages which lead to the identification of *Rhaetogonyaulax rhaetica* Zone. The assigned age of this dinozone (Rhaetian) is justified by plant fossils such as *Equisetites arenaceus, Scytophyllum persicum, Pterophyllum bavieri, Pterophyllum aequale* and *Nilssoniopteris musafolia* recorded from these strata. The dinoflagellate cysts show close similarities with assemblages reported from Australia, Northwest Europe, Arctic Canada and Northern Iran. Furthermore, the associated marine palynomorphs (dinoflagellate cysts), accompanied by spores grain indicate a nearshore depositional environment for the Late Triassic (Rhaetian) deposits in Tabas Block of Iran.

Keywords: *Late Triassic, Dinoflagellate cysts, Palaeobiogeography, Tabas block, Iran*.

Introduction

The Upper Triassic Nayband Formation in Tabas Block, of East-Central Iran has been divided into the Gelkan, Bidestan, Howz-e-Sheikh and Howz-e-Khan members. The Gelkan Member contains shales and sandstones with an age of Early Norian; the Bidestan Member containing sandstones, shales and reefal limestones with common Heterastridium has been assigned an age of middle-late Norian, while the Howz-e-Sheikh Member containing shales and sandstones and the Howz-e-Khan Member with shales, sandstones and reefal limestones containing algae, calcareous sponges and corals have both been assigned a Rhaetian age (Seyed-Emami, 2003; Cirilli *et al*., 2005). The Nayband Formation at the type section has a 2195 m thickness (Seyed-Emami, 2003) but this formation at the section studied here, is different in terms of lithology and thickness such that lithologically it consists mainly of shales and sandstones interbedded with thin bedded limestone, marl and coal and its thickness reduced to 1847 m. Furthermore, the upper carbonate member (the Howz-e-Khan Member) is partly or entirely replaced by a thick, siliciclastic sequence with prominent coal-measures informally named by the geologists of the National Iranian Steel Company Qadir Member (Bragin *et al*., 1981). The Qadir Member, studied palynologically, has a thickness of 435 m, and is composed of alternations of shales and sandstones interbedded with thin bedded limestone and coal seams (Fig. 2). This study shows that the lower part of the Qadir Member is rich in marine (dinoflagellate cysts) and terrestrial (spores and pollen grains) palynomorphs. The marine elements used in this study were for palynostratigraphy, palaeogeography and palaeoenvironmantal interpretations.

Geological setting

Upper Triassic strata of the Nayband Formation are well developed at Southwest Tabas, Parvadeh mine, East-Central Iran. The studied section of the Nayband Formation is situated within a tectonic unit called the Tabas Block in Central-East Iranian Microcontinent (Takin, 1972) and together with the Alborz Mountains and Central Iran, forms the Iran Plate (Wilmsen *et al*., 2009). The Parvadeh section located 75 km south of Tabas City, center of the Tabas Block together with the Yazd Block in the west and Lut Block in the east, forms the so-called Central and East Iranian Microcontinent [(CEIM), (Fig. 1)].

Materials and Methods

In this study, 116 rock samples were collected from the Qadir Member of the Nayband Formation at Parvadeh section, North Tabas block and prepared in the palynology laboratory of the Exploration Directorate of the National Iranian Oil Company (NIOC). The preparation method of Traverse

(2007) was used. Cold hydrochloric (20%) and hydrofluoric (50%) acids were used to dissolve carbonates and silicates. The residue was neutralized and centrifuged in $ZnCl_2$ (specific gravity 1.9), then sieved with a 15 µm nylon mesh, and mounted on microscopic slides using liquid Canada balsam. The samples were designated with the National Iranian Oil Company code number with the prefix MZY. The microscopic slides were examined with a Ziess optical microscope equipped with a Delta Pix (DP 450) Camera by which the index species were photographed and the photomicrographs of the selected dinoflagellate cyst specimens have been compiled and presented in Plates I and II. The slides were housed at the Department of Geology and Geochemistry of the Exploration Directorate of the NIOC.

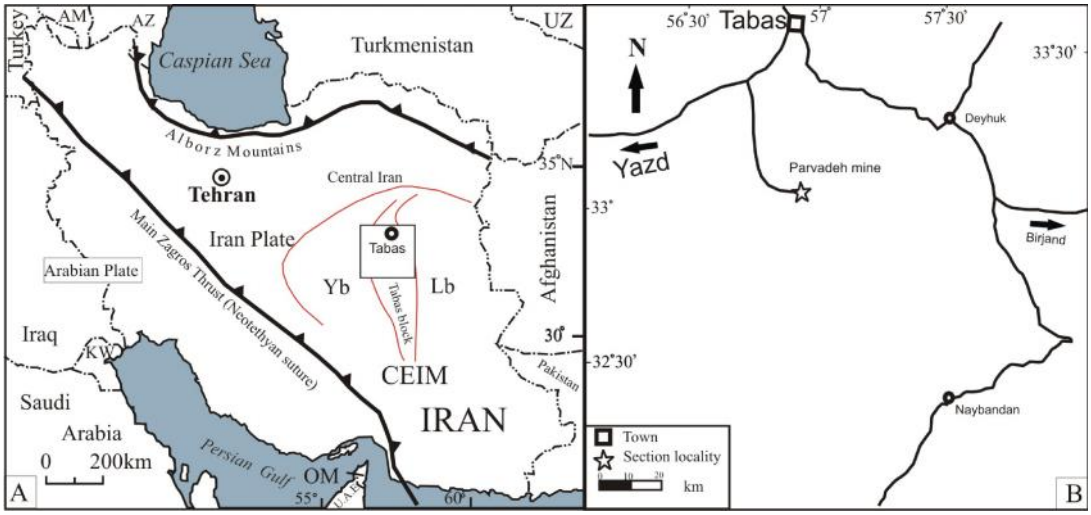

Figure 1. (A) Structure and geographic framework of Iran showing the main sutures, structural units and geographic areas (redrawn from Wilmsen et al., 2009). AR: Armenia, AZ: Azerbaijan, UZ: Uzbekistan, Yb: Yazd Block, Lb: Lut Block, CEIM: Central-East Iranian microcontinent, OM: Oman, UAE: United Arab Emirates, KW: Kuwait. (B) Location map of the section studied at Parvadeh, East Central Iran.

Previous studies

The Nayband Formation is the extensive and predominantly marine facies development of the Upper Triassic in eastern parts of Central Iran (Douglas, 1929; Stöcklin, 1961; Brönnimann *et al*., 1971; Kluyver *et al*., 1983a). The thickness of the formation decreases from 2195 m at the type section in East-Central Iran to only 80 m in Southern Iran (Senowbari-Daryan, 1996). The Qadir Member being studied here, introduced in an unpublished report of the National Iranian Steel Company by Bragin *et al*. (1976), has never been formalized. The member corresponds to member 5 of the Nayband Formaton of Kluyver *et al*. (1983b). The Upper Triassic successions of the Central Iran and Alborz basins have previously been investigated palynologically by Arjang (1975), Achilles *et al*. (1984), Ghasemi-Nejad *et al*. (2004) and Cirilli *et al*. (2005). Arjang (1975) sampled the coal-bearing deposits of Kerman area through several stratigraphic sections dated as Rhaetian, Liassic, and Dogger. Achilles *et al*. (1984) has also described miospores from the Mesozoic (upper Triassic-Jurassic) strata of the Kerman Basin (Central Iran), Zangerud (Western Alborz Mountains), Zirab (North Central Alborz) and Tazareh (Eastern Alborz) and introduced several miospore zones. Mannani and Yazdi (2009) sampled Qadir Member in the Bagher Abad area (North of Esfahan), recorded *Indopecten glabra* (bivalve) and assigned a Rhaetian age to this member. Fürsich *et al*. (2005) assigned a marginal marine environment to lower part of the Qadir Member at Parvadeh area. Vaez-Javadi (2012) and Jalali-fard *et al*. (2011) recorded plant macrofossils from the Qadir Member of the same section being studied and assigned a Rhaetian age to this member.

Palynology and palynostratigraphy

The aim of this study is to summarize the stratigraphic range of the dinoflagellate cyst assemblages recorded in the Qadir Member of the Tabas Block (Central Iran) and to erect a cyst

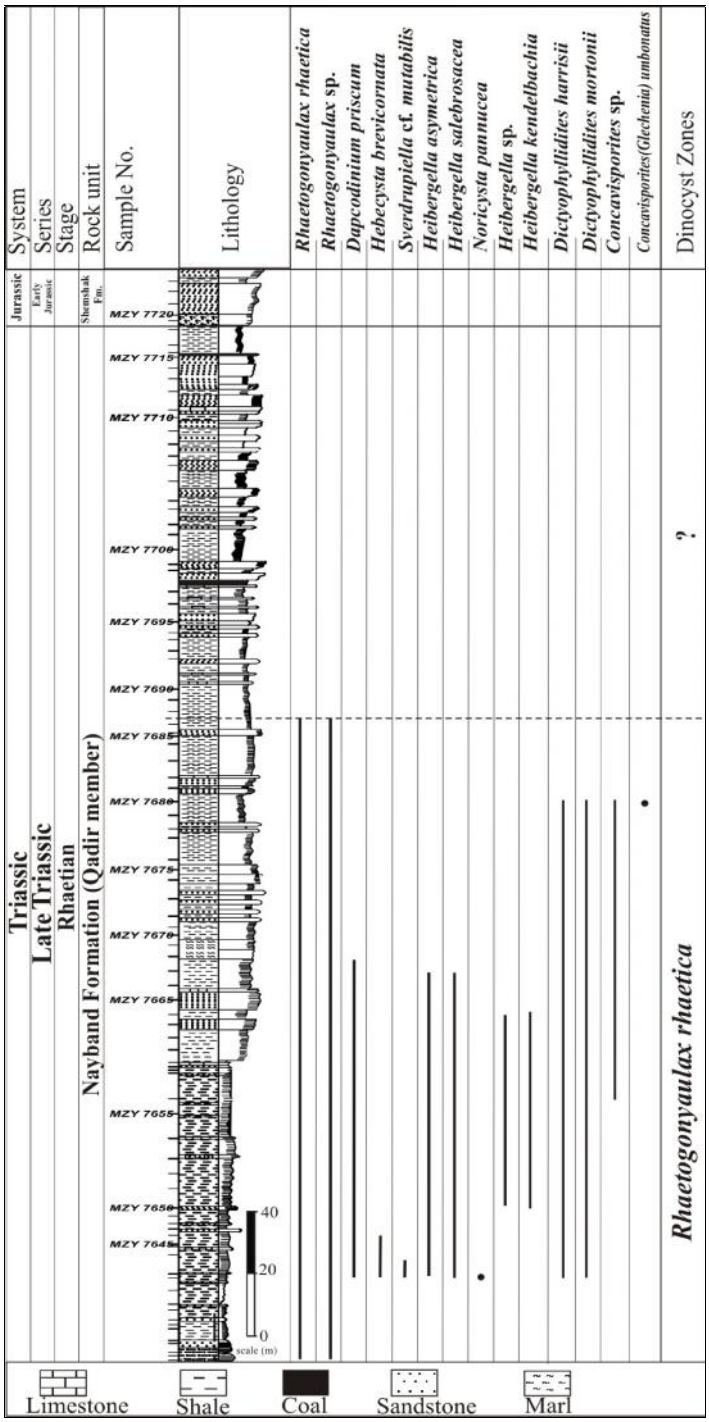

Figure 2. Biozone and stratigraphic distribution of dinoflagellate cysts throughout the Qadir Member

zonation to compare with zonal assemblages reported from other parts of Iran and the world. Palynologically productive samples were generally confined to the lower part of the Qadir Member at the studied section which is made up of shale, sandstone and thin bedded coal with a thickness of 200 m.

Twenty one out of the 116 rock samples prepared yielded dinoflagellate cysts. The assemblages recorded, though not well-preserved a yield of 8 species including taxa such as: *Heibergella asymmetrica*, *Heibergella* sp., *H.*

kendelbachia, *H. salebrosacea*, *Hebecysta brevicornata*, *Sverdrupiella* cf. *mutabilis*, *Dapcodinium priscum*, *Rhaetogonyaulax* sp., *Rhaetogonyaulax rhaetica*, and *Noricysta pannucea* (Plates I & II). Based on the first and last appearances of the *R. rhaetica*, the Rr Zone of Woollam and Riding (1983) has been recognized which is being discussed as follows:

Rhaetogonyaulax rhaetica Interval Biozone

This biozone is defined as the interval between the FAD and the LAD of *R. rhaetica* and is given an age of Rhaetian (Woollam & Riding, 1983). The index specis, *R. rhaetica* has been recorded abundantly through the zone. The zone ranges from sample MZY 7629 to sample MZY 7687 and encompasses 200 m of the base of the Qadir Member. The zone corresponds to the *R. rhaetica* (Rr) Zone of Woollam and Riding (1983) for Great Britain and the DSTr of Poulsen and Riding (2003) for Subboreal Northwest Europe (Fig. 3). This zone has also been used by Helby *et al*. (1987) for lower Rhaetian strata in Australia. Nicoll and Foster (1994) and Haq *et al*. (1987) reported and dated this zone as early Rhaetian. Ghasemi- Nejad *et al*. (2004) recorded this zone in Alborz Mountains of North Iran and dated it as Rhaetian (Fig. 3).

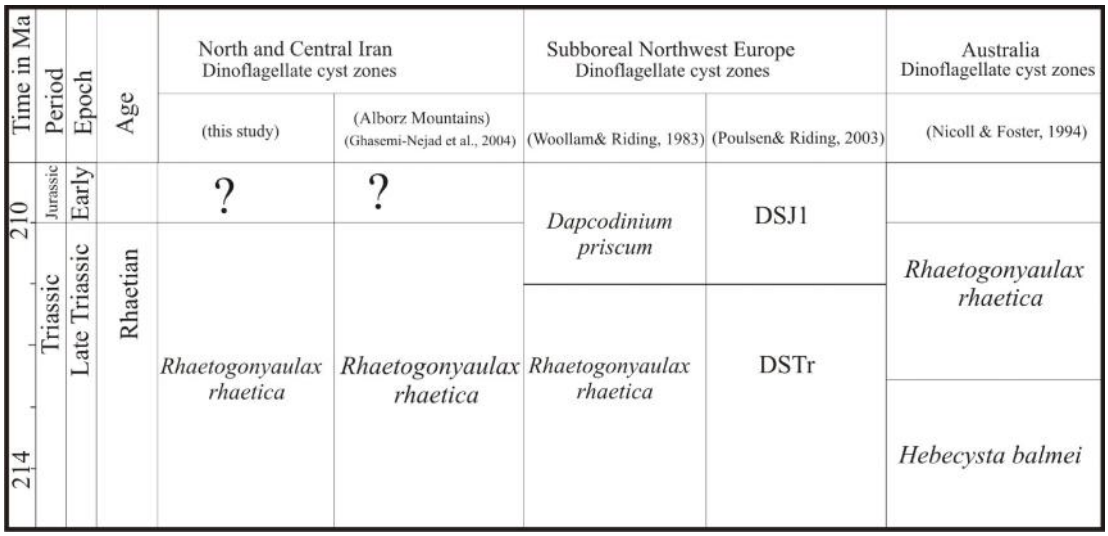

Figure 3. Comparison and correlation of the Rhaetian dinoflagellate cyst zonation erected for the Qadir Member of Nayband Formation, with those of Northwest Europe (Poulsen and Riding, 2003; Woollam & Riding, 1983), Australia (Nicoll & Foster, 1994) and the North Iran (Ghasemi- Nejad *et al.*, 2004). Time in Ma taken from Haq *et al.* (1987).

Different species of *Heibergella* and *Sverdrupiella* have been recorded in the northern hemisphere from Carnian to Rhaetian and in the southern hemisphere from Norian to Rhaetian (Bucefalo Palliani & Buratti, 2006). *Heibergella asymmetrica*, *Heibergella salebrosacea*, *Sverdrupiella mutabilis*, *Dapcodinium priscum*, *Noricysta pannucea* and *R. rhaetica* have been recorded from Late Triassic (Rhaetian) deposits of southern England (Bucefalo Palliani & Buratti, 2006). *Sverdrupiella mutabilis*, *Dapcodinium priscum*, *R. rhaetica* and *Heibergella kendelbachia* have also been recorded from *R. rhaetica* biozone in Rhaetian of Northwest Europe (Powell, 1992; Poulsen and Riding, 2003). Morbey (1975) recorded *R. rhaetica* and *H. kendelbachia* in the Rhaetian of Austria. In addition to dinoflagellate cysts, the following miospores taxa have been seen in this member: *Dictyophyllidites harrisii*, *Concavisporites (Gleichenia) umbonatus*, *Dictyophyllidites mortonii* and *Concavisporites* sp. Therefore, based on these palynological evidences, a Rhaetian age can be proposed for this biozone at the study section. Moreover, Plant fossils recorded such as *Equisetites arenaceus*, *Scytophyllum persicum*, *Pterophyllum bavieri*, *Pterophyllum aequale* and *Nilssoniopteris musafolia* (Vaez-Javadi, 2012) confirm the age Rhaetian for the

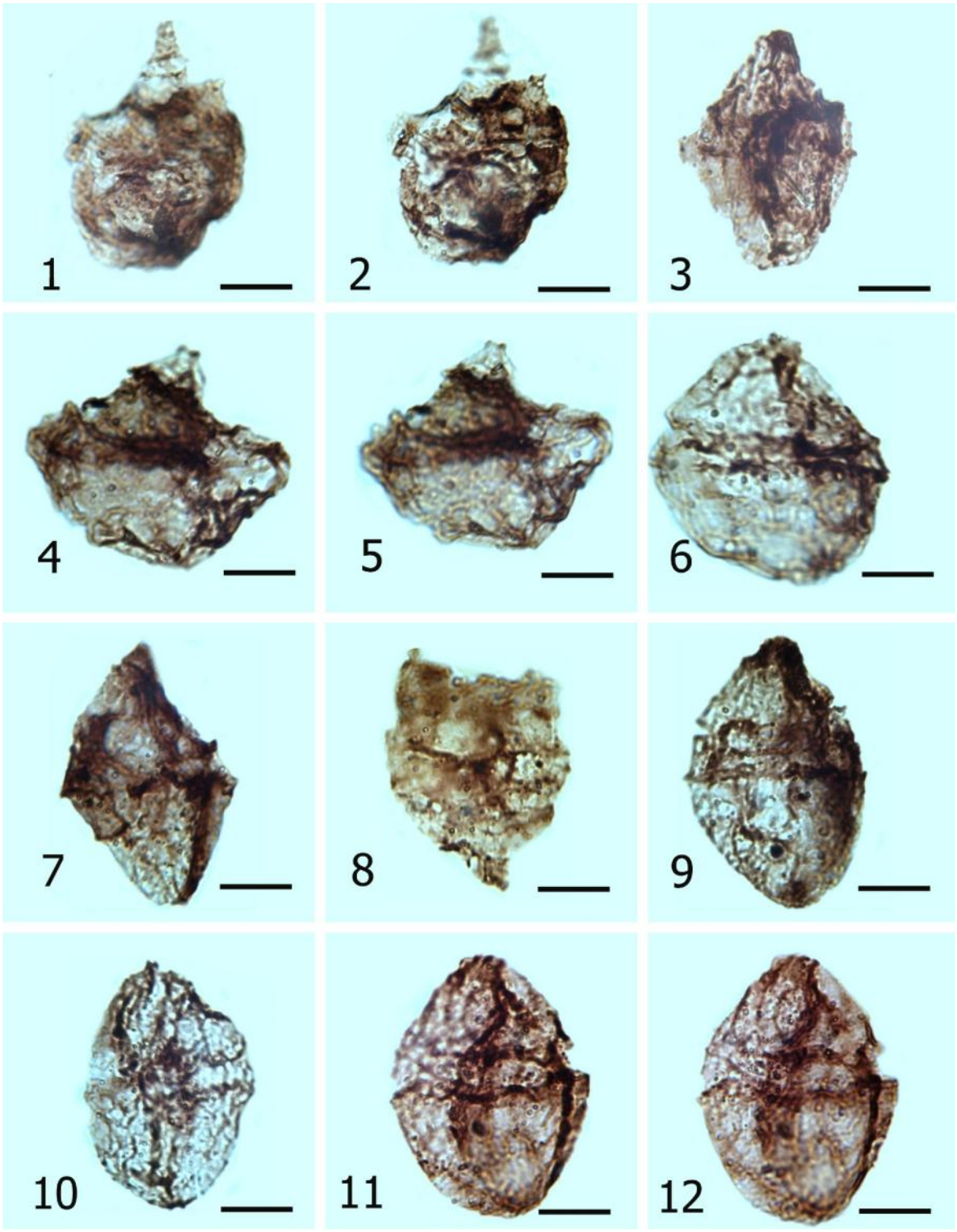

Plate I

Dinoflagellate cysts recorded from the Qadir Member of the Nayband Formation (Rhaetian) East-Central Iran. The scale bar represents 10 µm. 1, 2. *Heibergella asymmetrica* Bujak and Fisher, 1976. 1-2: sample MZY - 7641, slide d. 3. *Sverdrupiella* sp. cf. *S. mutabilis* Bujak and Fisher, 1976. sample MZY - 7641, slide a. 4, 5. *Heibergella asymmetrica* Bujak and Fisher, 1976. 4-5: sample MZY - 7666, slide b. 6. *Heibergella* sp. samp le MZY - 7641, slide c. 7. *Rhaetogonyaulax rhaetica* (Sarjeant, 1963) Loeblich and Loeblich, 1968. sample MZY - 7641, slide a. 8. *Rhaetogonyaulax* sp. sample MZY - 7638, slide d. 9-12. *Heibergella* sp. 9-10: sample MZY - 7641, slide b, 11-12: sample MZY - 7641, slide c.

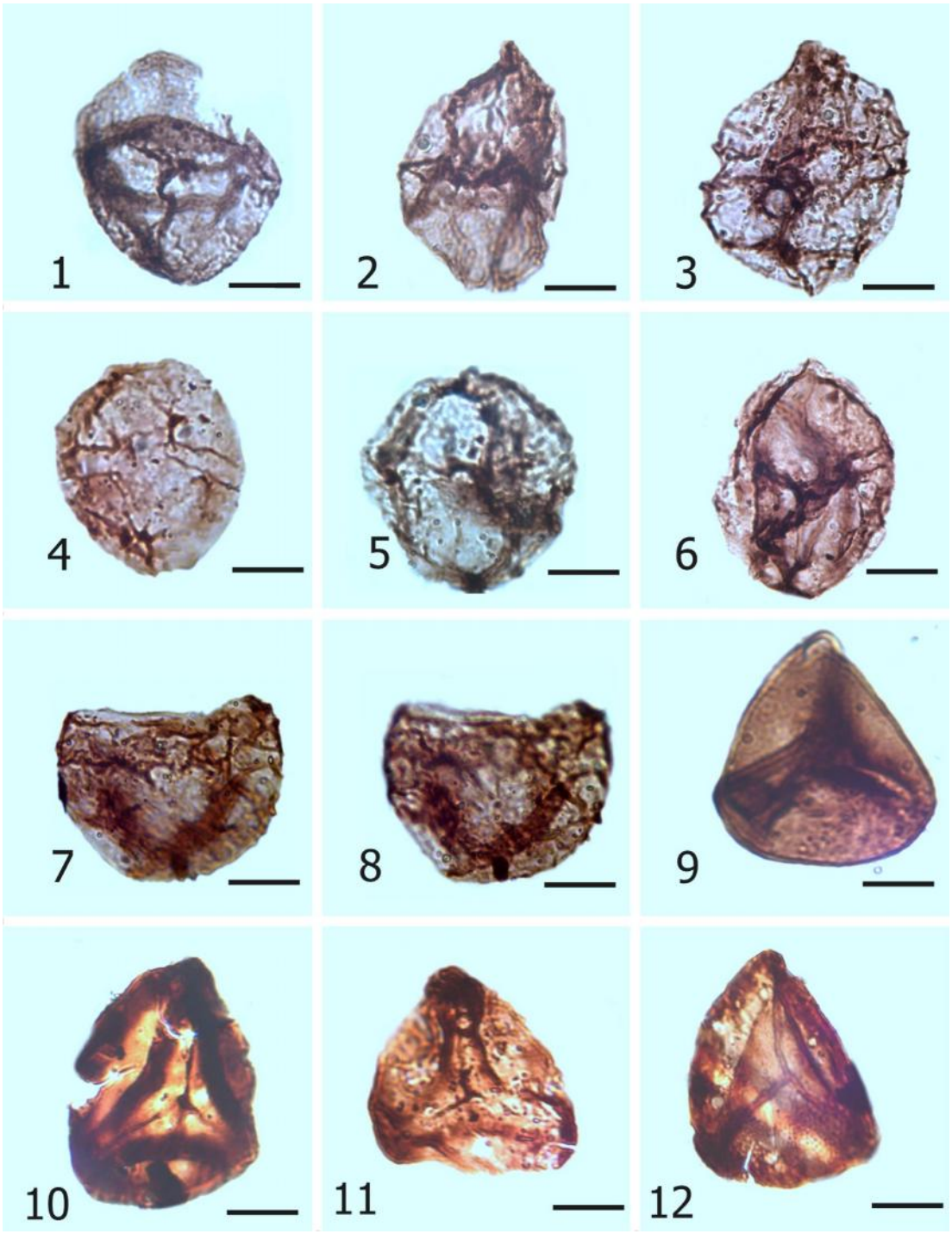

Plate II

Dinoflagellate cysts recorded from the Qadir Member of the Nayband Formation (Rhaetian) East-Central Iran. The scale bar 10 µm. 1. *Heibergella kendelbachia* (Morbey) Lentin and Williams 1981. sample MZY - 7641, slide d. 2, 3. *Heibergella salebrosacea* Bujak and Fisher, 1976. 2: sample MZY - 7641, slide b, 3: sample MZY - 7641, slide c. 4. *Noricysta pannucea* Bujak & Fisher 1976. sample MZY - 7641, slide c. 5. *Heibergella* sp. sample MZY - 7641, slide a. 6. *Hebecysta brevicornata* Bujak and Fisher, 1976. sample MZY - 7642, slide d. 7-8. *Dapcodinium priscum* Evitt, 1961. 7-8: sample MZY - 7641, slide b. 9. *Dictyophyllidites harrisii* Couper, 1958. sample MZY - 7641, slide a. 10. *Concavisporites (Gleichenia) umbonatus* (Bolkhovitina. 1953) Arjang, 1975. sample MZY - 7680, slide a. 11. *Dictyophyllidites mortonii* (de Jersey) Playford& Detmann, 1965. sample MZY - 7641, slide b. 12. *Concavisporites* sp. sample MZY - 7680, slide b.

Qadir Member of the Nayband Formation at this locality. The records and differentiated zones mentioned are presented and compared in Figure 3.

Palaeobiogeography and Palaeoenvironment

The Upper Triassic (Norian-Rhaetian) siliciclastic-carbonatic deposits of the Nayband Formation crops out in the Central-East Iranian microcontinent as a part of the Cimmerian Continent (Seyed-Emani, 2003). The Cimmerian continent divided the Tethys into the northern Palaeotethys and the southern Neotethys [(Nützel & Senowbari-Daryan, 1999)]. According to Fürsich *et al*. (2005), the Nayband Formation was deposited after the early Cimmerian tectonic event. Palaeogeographic maps show that the Tabas block of Central-East Iranian microcontinent occupied the southern margin of Eurasia and northern margin of Neotethys during the Late Triassic (Wilmsen *et al*., 2009). The dinoflagellate cyst assemblages show close similarities with assemblages reported from Australia, Northwest Europe, Arctic Canada and Northern Iran.

The relative abundances of dinoflagellate cysts recorded in the lower part of the Qadir Member indicate that it was deposited in a marine environment though, the accompanying spores and pollen grains indicate a nearshore depositional environment for this Late Triassic (Rhaetian) member in the Tabas Block. This is in accordance with Kluyver *et al*. (1983) and Fürsich *et al*. (2005), (2005), who believe that the first four members of the type section of the Nayband Formation including the Qadir Member, accumulated in shallow to marginal marine environments. Vaez-Javadi (2012) who sampled the Qadir Member of the same section reported diverse plant fossils from this rock succession and suggested a moist and warm climate for the Rhaetian in this area.

Conclusion

The Qadir Member of the Nayband Formation in the Parvadeh area of the Tabas block, East – Central Iran yielded moderately diverse dinoflagellate cyst assemblages indicative of a Late Triassic (Rhaetian) age in comparison with northwest Europe, Australia and Northern Iran. Association of marine palynomorphs (dinoflagellate cysts) with spores and pollen grains indicate a nearshore depositional environment for these Late Triassic deposits in the Tabas Block of Iran.

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