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Nannostratigraphy of Gurpi Formation (Cretaceous -Tertiary Boundary) In Zagros Basin, Southwestern Iran

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Abstract: The Gurpi section in northwestern Shiraz, faulted zagros range of southwestern Iran, contains one of the most complete Early Santonian to Danian sequences. The lack of a good fundamental paleontological study is a strong motivation for investigating calcareous nannofossils in southwestern Iran. The Gurpi Formation is mainly made up of shale and marl. As a result of this study, 23 genera and 46 species of nannofossils have been identified for the first time. This confirms the existence of biozones CC14-CC26 and NP1, which suggests the age of Early Santonian to Danian. All Early Santonian to Danian calcareous nannofossils biozones from CC14 (equivalent to the *Micula decussate* zone) to NP1 (equivalent to the *Markalius inversus* zone) are discussed. Also, the zonal subdivision of this section based on calcareous nannofossils is show continuity in KT boundary in northwest part of Shiraz. We can also learn about the predominant conditions of the studied sedimentary basin that are in fact a part of Neotethys basin with the existence of indexed species calcareous nannofossils that indicate warm climate and high depths of the basin in low latitudes.

Key words: Calcareous nannofossils · Gurpi Formation · Palaeoecology

INTRODUCTION

The Zagros basin is composed of a gently folded rock succession. The geologic structure has northwestern-southeastern and consists of a group of condensed anticlines. The basin is composed of a gently folded rock succession comprising more than 10000m of Mesozoic to Neogen strata. The sediments were deposited in a gradually subsiding trough, which was formed in the Late Triassic. The Gurpi Formation is exposed throughout most of the Agreement Area along the northwestern Shiraz, southwestern Iran. This Formation in Zagros basin is lateral change. The Shiraz section discussed in this paper is located in Bavan area, the Shiraz Province, about 105 km northwest of Shiraz (Figure 1). At this locality, the Gurpi Formation consists of 184m-thick succession and covers the area between longitudes E51°, 45' to E51°, 35' and latitudes N29°, 55' to N30°, 05'. The formation is made up of shale, marl and is itself overlain by the purple shale of Pabdeh Formation. This formation unconformity overlies limestone of the Sarvak Formation (Table 1). The Gurpi Formation, which includes the Cretaceous-Tertiary transition in southwestern Iran, has been extensively studied previously [1, 2]. The Gurpi frormation at the type section (E49°13' 47", N32° 26' 50") is composed of 320m grey to blue marl and shale beds and occasionally thin beds of argillaceous limestones [1, 3, 4]. Few studies on Upper Cretaceous calcareous nannofossils have been carried out in Iran [5, 6]; are focused on the Kopet-Dagh Range. Most of palaeontological studies on the Cretaceous of the

Fig. 1: Location of studied area

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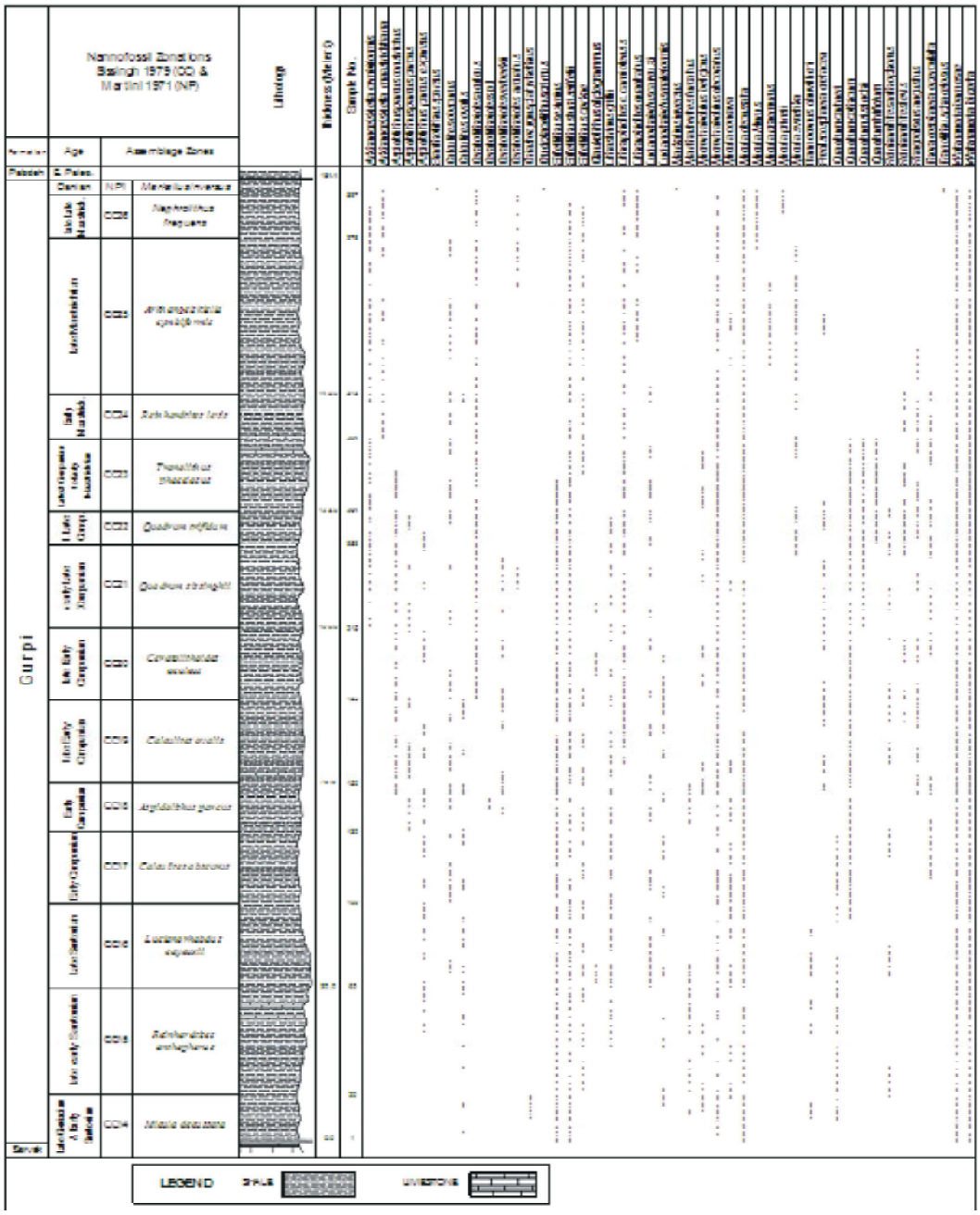
Table 1: Biozonation of Gurpi Formation based on Calcareous Nannofossils



faulted Zagros and particulary of the Gurpi Formation, have been performed using foraminifers. Microfauna of the Gurpi formation were studied by Jalali and Zahiri [7, 8]. These micropalaeontologists did not identify any biozones but they defined the Santonian-Maastrichtian age of the Gurpi Formation based on various localities in the faulted Zagros. In recent years the Upper Cretaceous in the Zagros basin was studied based on the calcareous nannofossils [9]. The samples for the present study were collected from the base to top of the Gurpi Formation. The main purpose of our research was to establish a biostratigraphic zonation and determine of Cretaceous-Tertiary Boundary. This study is based on the recognized calcareous nannofossil assemblages and defines the age of the formation. This is a research-experimental study.

MATERIALS AND METHODS

A total of 399 samples representing the oldest and youngest strata of the 184.4 m succession, were collected up to the contact with the Pabdeh Formation. The most detailed sampling was performed in the intervals at 1m below and above boundaries of the Gurpi Formation. From this set of samples the Santonian to Danian biozones were identified and the species ranges were determined. Samples examined for calcareous nannofossils content were prepared using the smear-slide techniques. For this work, all outer surfaces of the samples were trimmed with a razor-blade to obtain a new fresh material. Then a small amount of sediment was scraped onto a glass slide and diluted with distilled water to make a thick sediment suspension using a flat-sided toothpick and then dried on a hotplate. Between preparations, the razor used in the preparation was washed in distilled water. The counter and the hotplate used in making the smear-slides were wiped with 10% Hydrochloric acid between sample preparations. This was done to reduce the chance of contamination. All slides were examined under an Olympus BH-2 light-microscope at 1250x magnification. The Marker and the most common species are illustrated in Plate 1.

Calcareous Nannofossils: Calcareous nannofossils abundances are moderate to high within the study area. The species *Eiffellithus turriseiffelii, Micula decussate, Watznaueria barnesae, Watznaueria biporta, Ceratolithoides aculeus* and *Microrhabdulus decoratus* are the major components and abundant of the assemblages. *Quadrum trifidum, Eiffellithus eximius, Micula murus, Arkhangelskiella cymbiformis, Quadrum gothicum, Lithraphidites carniolensis, Lucianorhabdus maleformis, Micula swastika, Prediscospheara cretacea, Lucianorhabdus cayeuxii* are relatively numerous. *Tranolithus phacelosus*, *Marthasterites furcatus, Lucianorhabdus cayeuxii, Micula praemurus*, *Thoracosphaera operculata* and *Micula prinsii* are rare. Most Cretaceous nannofossil taxa became extinct below the first violet marly intercalation, a bioevent that is synchronous with the Cretaceous/Tertiary (K/T) Boundary Event in low-mid latitude areas [2, 10, 11]. The palaeoclimate and depth of the sedimentary basin can be explained using the index species of calcareous nannofossils. The presence of the species mentioned above in the studied samples could indicate a very deep basin and tropical climate conditions. From the records on abundance and diversity of the low-latitude species, which are known to be very useful indexes for the Late Cretaceous [3, 12], we concluded that the sedimentary basin was located in a low latitude and tropical environment.

Biostratigraphy: Calcareous nannofossils recorded in the Cretaceous strata are believed to be appropriate means for biostratigraphic studies [13, 14, 15, 16]. The importance of these calcareous nannofossils for Correlation has been discussed at length by Perch-Nielsen [10, 11]. The examination of calcareous nannofossils of the Gurpi Formation at Zagros basin (northwestern Shiraz) enabled us to recognize most of the standard biozones defined in Mediterranean regions, especially Tethysian domain [17, 18, 19]. In Zagros basins few studies of cretaceous calcareous nannofossils have been carried out on Gurpi Formation [9, 20]. Calcareous nannofossil abundances are moderate to high within the study area. In the Santonian to Danian the biozones CC14 to CC26 and zone NP1 were identified using the zonal scale that subdivides the upper Cretaceous and Paleocene to biozones [10, 11, 12]. Fourteen biozones were recognized. These zonal schemes are shown in Table 1 and are compared with the other commonly used zonations, the taxa discussed in this section are illustrated in Plate 1.

The first nannofossil unit recorded from the shale of the Gurpi Formation is that from the first occurrence (FO) of *Micula decussate* to the FO of *Reinhardtites anthophorus*. This interval is similar to CC14 zone distinguished in the Early Santonian [14, 11, 12]. Zone CC15 is defined as the interval from the FO of *Reinhardtites anthophorus* to the FO of *Lucianorhabdus cayeuxii* [14, 17, 10]. The age of zone is Late Early Santonian.

The next nannofossil unit recorded in the shale of the Gurpi Formation is the FO of *Lucianorhabdus cayeuxii* and the FO of *Calculites obscurus*, which corresponds to the zones CC16 and CC17, assigned to the uppermost Santonian [17, 12, 11]. The next biounit is the zone CC18 defined as the interval from the FO of *Aspidolithus ex. gr. Parcus* to the last occurence (LO) of *Marthasterites furcatus*. The zone CC19 is distinguished as the interval from the LO of *Marthasterites furcatus* to the FO of *Ceratolithoides aculeus*. The FO of *Ceratolithoides aculeus* is close to the Lower/Upper Campanian Boundary [10, 11]. The next bioevent recorded from the marls of the Gurpi Formation is the FO of *Quadrum sissinghii* [11]. The following event in the studied succession is the

Plate 1

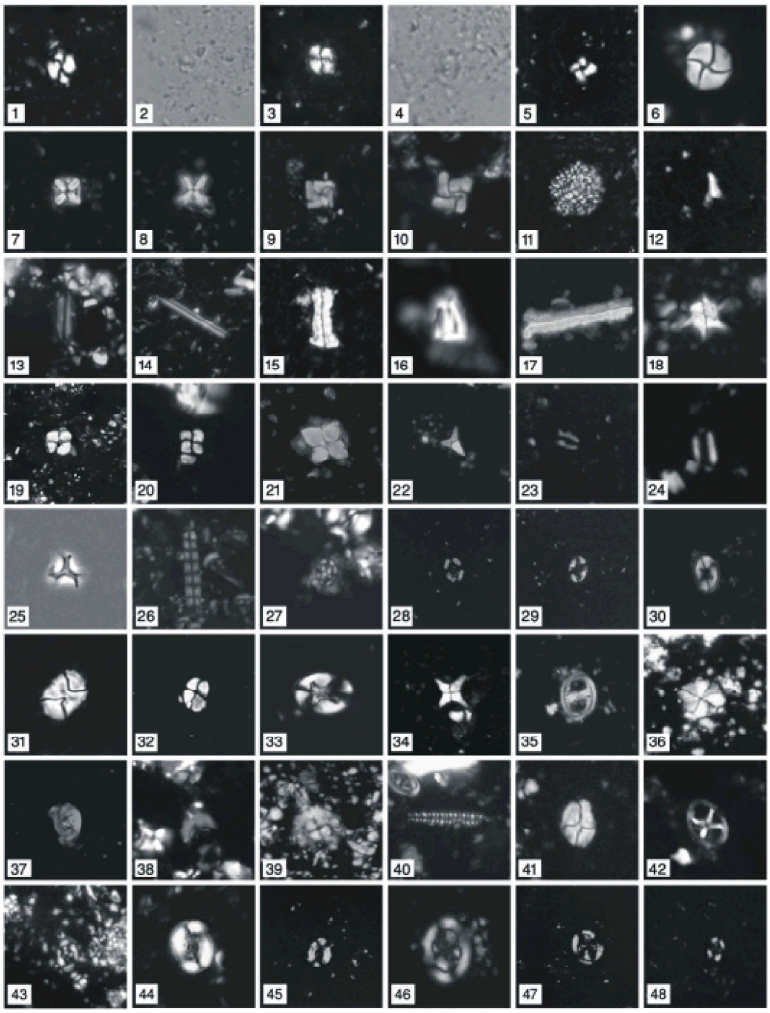


Plate 1: All figures in XPL except 2,4,25 in PPL, light microghraphs; 1-2. *Watznaueria barnesae* Black in Black & Barnes (1959), Perch-Nielsen (1968)(X2500); 3-4. *Watznaueria biporta* Bukry (1969)(X2500); 5. *Micula murus* Martini (1961), Bukry (1973) (X2500); 6. *Micula praemurus* Bukry (1973), Stradner & Steinmetz (1984)(X2500); 7. *Micula decussata* Vekshina (1959)(X2500); 8. *Micula concava* Stradner in Martini & Stradner (1960), Verbeek (1995)(X2500); 9. *Micula swastika* Stradner & Steinmetz (1984)(X2500); 10. *Micula prinsii* Perch-Nielsen (1979a)(X2500); 11. *Thoracosphaera operculata* Bramlette & Martini (1964)(X1250); 12. *Ceratolithoides aculeus* Stradner (1961), Prins & Sissingh in Sissingh (1977)(X1250); 13. *Lithraphidites quadratus* Bramlette & Martini (1964)(X2500); 14. *Lithraphidites carniolensis carniolensis* Deflandre (1963)(X2500); 15. *Lucianorhabdus maleformis* Reinhardt (1966)(X2500); 16. *Ceratolithoides verbeekii* Perch-Nielsen (1979a)(X2500); 17. *Lucianorhabdus cayeuxii* Deflandre (1959)(X2500); 18. *Lithastrinus grillii* Stradner (1962)(X2500); 19. *Quadrum gartneri* Prins & Perch-Nielsen in Manivit et al.(1977)(X1250); 20. *Quadrum gartneri* Prins & Perch-Nielsen in Manivit et al.(1977)(X2500); 21. *Quadrum gothicum* Deflandre (1952), Hattner & Wise (1980)(X1250); 22. *Quadrum trifidum* Stradner in Stradner and Papp (1961), Hattner & Wise (1980)(X1250); 23. *Nannoconus dauvillieri* Deflandre & Deflandre (1959)(X1250); 24. *Rhagodiscus angustus* Stradner (1963), Reinhardt (1971)(X1250); 25. *Marthasterites furcatus* Deflandre in Deflandre & Fert (1954), Deflandre (1959)(X1250); 26. *Microrhabdulus decoratus* Deflandre (1959)(X2500); 27. *Prediscosphaera cretacea* Arkhangelsky (1912), Gartner (1968)(X1250); 28. *Aspidolithus parcus expansus* Wise & Watkins in Wise (1983), Perch-Nielsen (1984a)(X1250); 29. *Eiffellithus eximius* Stover 1966, Perch-Nielsen (1968)(X1250); 30. *Eiffellithus gorkae*

Reinhardt (1965) (X1250); 31-32. *Calculites obscurus* Deflandre (1959), Prins & Sissingh in Sissingh (1977) (X2500); 33. *Eiffellithus turriseiffelii* Deflandre in Deflandre & Fert (1954)(X2500); 34. *Quadrum sissinghii* Perch-Nielsen (1986b)(X2500); 35. *Reinhardtites anthophorus* deflandre (1959), Perch-Nielsen (1968)(X2500); 36. *Biantholithus sparsus* Bramlette & Martini (1964)(X2500); 37. *Reinhardtites levis* Prins & Sissingh in Sissingh (1977)(X2500); 38. *Ceratolithoides arcuatus* Prins & Sissingh in Sissingh (1977)(X2500); 39. *Markalius inversus* (Deflandre in Deflandre & Fert (1954)), Bramlette & Martini (1964)(X2500); 40. *Microrhabdulus belgicus* Hay & Towe (1963)(X2500); 41. *Calculites ovalis* Stradner (1963), Prins & Sissingh in Sissingh (1977)(X2500); 42. *Chiastozygus platyrhethus* Hill (1976)(X2500); 43. *Cruciplacolithus primus* Perch-Nielsen (1977)(X1250); 44. *Aspidolithus parcus constrictus* Hattner et al. (1980), Perch-Neilsen (1984a)(X2500); 45. *Aspidolithus parcus parcus* Stradner (1963), Noël (1969)(X1250); 46-47. *Arkhangelskiella cymbiformis* Vekshina (1959), Perch-Nielsen (1989)(X1250); 48. *Arkhangelskiella maastrichtiana* Burnett (1998b)(X1250).

FO of *Quadrum trifidum* also referred to the uppermost Campanian. The successive LO of nannofossils *Quadrum trifidum* and *Eiffellithus eximius* are recorded in the marls of the Early Maastrichtian age [14, 11]. The next bioevents, recorded towards the top of the formation are the successive FO of *Lithraphidites quadratus*, *Micula murus* and *Micula prinsii*, dated as Late Maastrichtian [21, 2, 11, 12, 18, 19]. The last unit recorded in the shale of the Gurpi Formation is the zone NP1 defined as the interval from the LO of Cretaceous coccoliths or FO of acme of *Thoracosphaera* to FO *Cruciplacolithus tenuis*. A bioevent that is synchronous with the Cretaceous/Tertiary (K/T) Boundary Event in low-mid latitude areas. Above this extinction are two successive blooms, one of the dinoflagellate cyst genus *Thoracosphaera* and the other of the nannofossil *Braarudosphaera bigelowii*. These blooms have been recorded in many mid-latitude areas, slightly above the K/T Boundary Event, in the lowermost Paleocene [14, 10, 11].

CONCLUSIONS

As a result of this study 23 genera and 46 species of nannofossils have been identified in northwestern Shiraz (Bavan area), southwestern Iran for the first time. Based on the obtained nannofossils, the age of the studied section is defined as Santonian to Danian, which corresponds to zones CC14-CC26 and NP1 zonation. The Gurpi Formation in section Shiraz is Fourteen biozones including: 1- *Micula decussate* 2- *Reinhardtites anthophorus* 3- *Lucianorhabdus cayeuxii* 4- *Calculites obscurus* 5- *Aspidolithus Parcus* 6- *Calculites ovalis* 7- *Ceratolithoides aculeus* 8- *Quadrum sissinghii* 9- *Quadrum trifidum* 10- *Tranolithus phacelosus* 11- *Reinhardtites levis* 12- *Arkhangelskiella cymbiformis* 13- *Nephrolithus frequens* 14- *Markalius inversus* were determined.

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