

# Stratigraphy and Identifying Boundaries of Mozduran Formation with Magnetite Method in East Kopet-Dagh Basin

Z. Kadivar, M. Vahidinia, A. Mousavinia

**Abstract**—Kopet-Dagh Mountain Range is located in the north and northeast of Iran. Mozduran Formation in the east of Kopet-Dagh is mainly composed of limestone, dolomite, with shale and sandstone interbedded. Mozduran Formation is reservoir rock of the Khangiran gas field. The location of the study was east Kopet-Dagh basin (Northeast Iran) where the deliberate thickness of formation is 418 meters. In the present study, a total of 57 samples were gathered. Moreover, 100 thin sections were made out of 52 samples. According to the findings of the thin section study, 18 genera and nine species of foraminifera and algae were identified. Based on the index fossils, the age of the Mozduran Formation was identified as Upper Jurassic (Kimmerdgian-Tithonian) in the east of Kopet-Dagh basin. According to the magnetite data (total intensity and RTP map), there is a disconformity (low intensity) between the Kashaf-Rood Formation and Mozduran Formation. At the top, where among Mozduran Formation and Shurijeh Formation, is high intensity and a widespread disconformity (high intensity).

**Keywords**—Upper Jurassic, magnetometer, Mozduran formation, stratigraphy.

## I. INTRODUCTION

KOPET-DAGH Mountain Range is stretched in the north and northeast of Iran. Kopet-Dagh Basin was formed following the Cimmerian orogeny and the collision of Turan plate with the Iranian plate [1].

More than 7000 meters sediments were deposited from Jurassic through Miocene time in the eastern part of the basin [2] Mozduran Formation dolomites are more in the eastern part than in the west part, and its thickness is more in the east than in the west [3]. The upper Jurassic Mozduran Formation is situated in a paraconformity and unconformity state on Kashaf-Rood Formation and in a paraconformity state below red siliciclastic rock of Shurijeh [12]. At some localities of the Kopet-Dagh region, the Mozduran Formation has a conformable contact with the Chaman Bid Formation. The upper boundary of the Mozduran Formation with Shurijeh Formation is erosional. However, no detailed information is available to reach any final conclusions. Nabaviyeh believed the boundary between the Mozduran Formation and the Shurijeh Formation to be transitional. Mozduran Formation is the reservoir rock of the Khangiran gas field [11]. The Mozduran Formation in the east of Kopet-Dagh is made of thick bedded limestone, dolomite with inter layers of shale and

sandstone. The thickness of the study section of Mozduran Formation is 418 meters. The main objective of this study is to determine boundaries of Mozduran Formation with magnetite method and the exact age of the Formation based on microfossils, thickness Mozduran Formation in east Kopet-Dagh.

## II. METHODS AND MATERIALS

The block section in the east of Kopet-Dagh Basin, which is located 90 km to the northeast of Mashhad in the Mozduran pass where the measured thickness of the Formation is 418 meters.

In this study, 52 rock samples and five shale samples were collected. Also, out of 52 samples, 100 thin sections were produced. To determine the boundary Mozduran Formation with Kashaf- Rood in beneath and Shurijeh development at the top, we utilized the magnetite method; 960 stations were taken by a proton magnetometer device (GEM Company), the UTM coordinates of the studied are presented in Table I.

TABLE I  
UTM COORDINATES OF THE STUDIED BLOCK

|   | Longitude [X] | Latitude [Y] |
|---|---------------|--------------|
| 1 | 277516.69     | 4006181.492  |
| 2 | 277963.96     | 4006572.863  |
| 3 | 277251.742    | 4006517.933  |
| 4 | 277656.403    | 4006865.946  |

The aim of a magnetic survey is to investigate subsurface geology on the basis of the anomalies in the earth's magnetic field resulting from the magnetic properties of the underlying rocks. In general, the magnetic content (susceptibility) of rocks is extremely variable depending on environment it is in. Common causes of magnetic anomalies include dykes, faults and lava flows.

The magnetic method involves the measurement of the earth's magnetic field intensity. Typically, the total magnetic field is measured. The magnetic method is typically used to:

1. Map basement faults and basic igneous intrusives.
2. Map formation boundaries (magnetic convolution), etc.

From the magnetic map several of the anomalies (convolution) can often be correlated with fields. A magnetic high anomaly is where the measured field strength is higher than the value predicated by the global model and a magnetic low is where the measured field strength is lower than the value predicated by the global model [14].

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Sedimentary rocks generally have a very small magnetic susceptibility compared with igneous or metamorphic rocks, which tend to have much higher magnetite (common magnetic minerals) content. The magnetometer is operated by GEM device (GeoMetrics Company) and data ready description by Surfer and ER- Mapper software [13]. The Mozduran Formation in the study section is made of carbonate rocks. At type locality, the Mozduran Formation has erosional contact with the Kashaf-Rood Formation, and the upper boundary of the Mozduran Formation with Shutijeh Formation is erosional

too [12]. According to the total intensity map (Fig. 2), there is a Magnetic convolution in these boundaries that may not be depositional, and for the RTP map (Fig. 3), there is a disconformity (low intensity) between the Kashaf-Rood Formation and Mozduran Formation. The analytical signal map of the study section helps us to identifying anomaly depth (Fig. 4). At the top, where among the Mozduran and Shurijeh Formations, there is high intensity and a widespread disconformity. The correlation magnetite data is marked on an aerial photo and presented in Fig. 5.

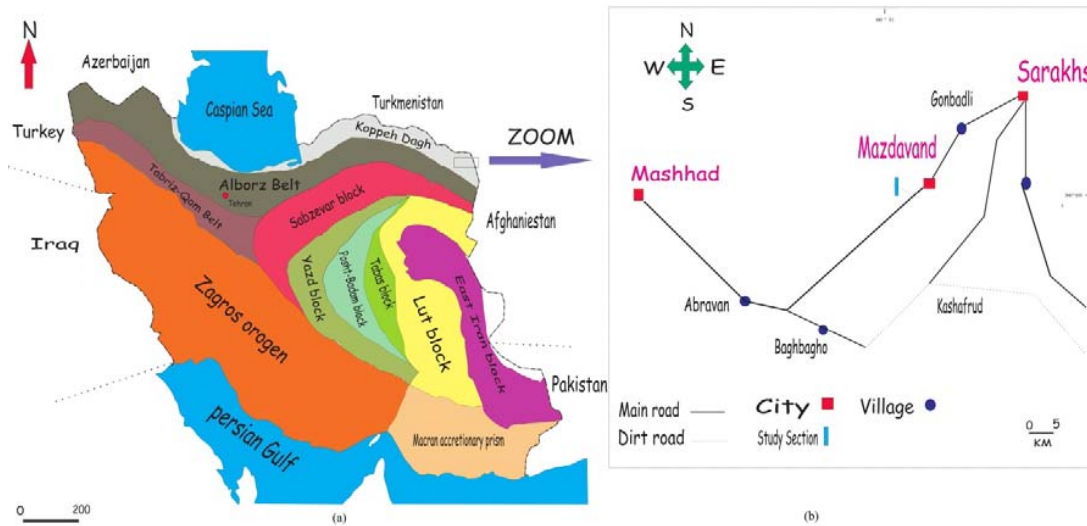


Fig. 1 (a) Location map of the study section, area of investigation; (b) Close-up view of the locations Magnetite method

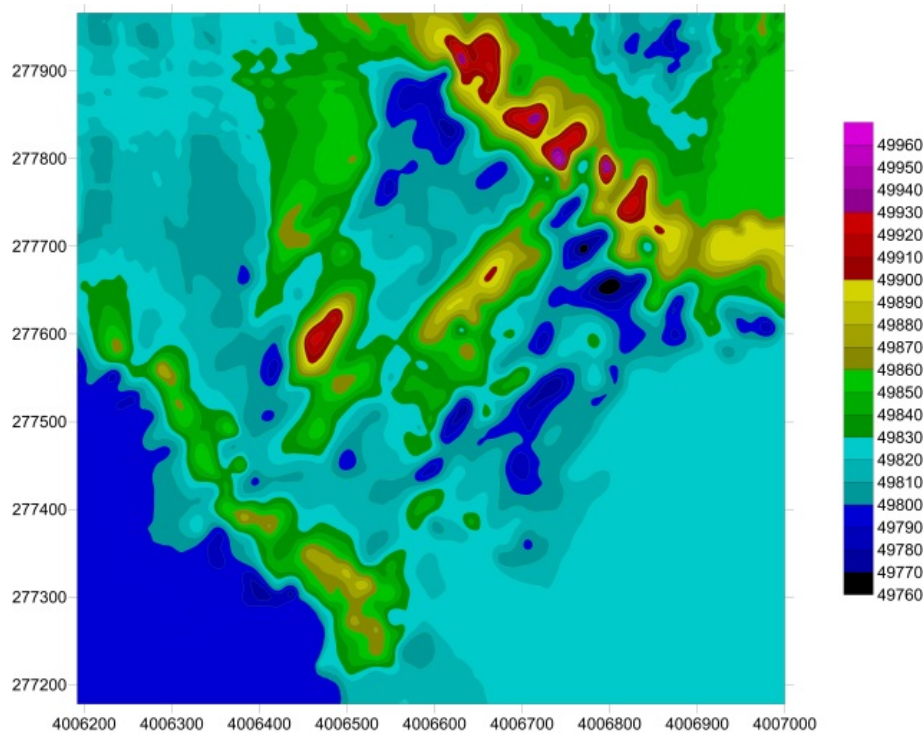


Fig. 2 Total intensity map of study section

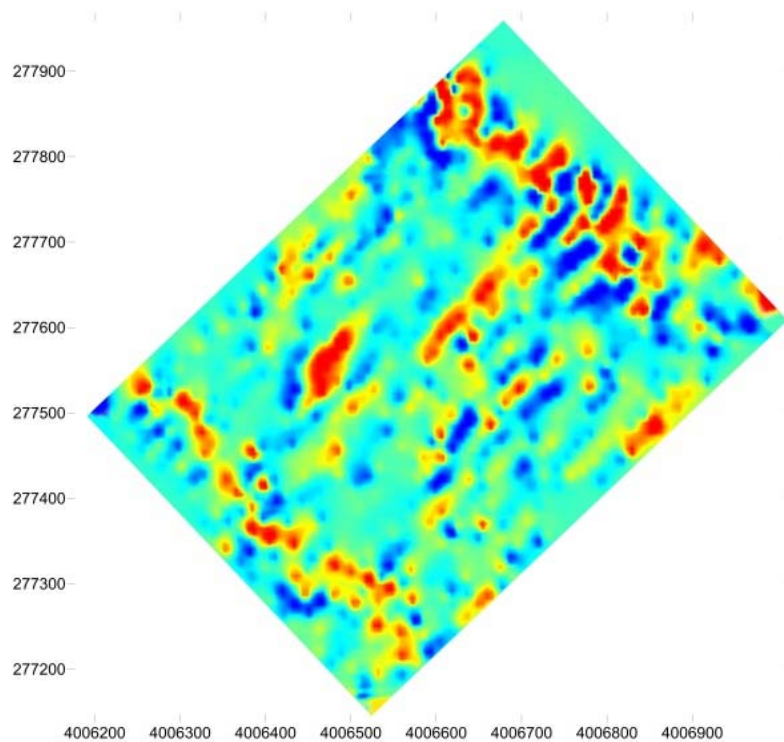


Fig. 4 Analytical signal map of study section

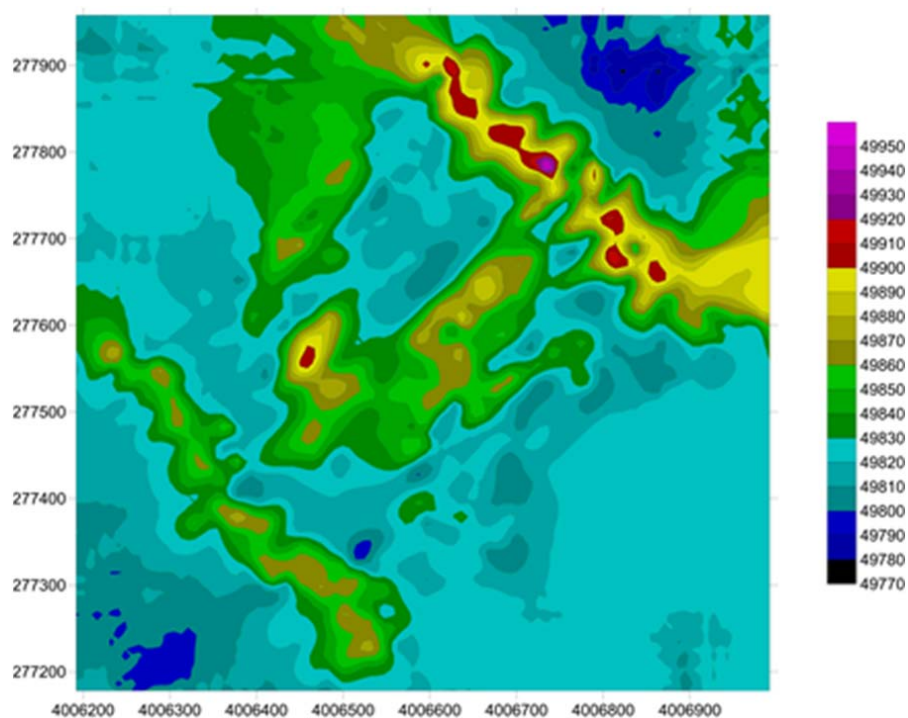


Fig. 3 Reduction to the pole map of study section

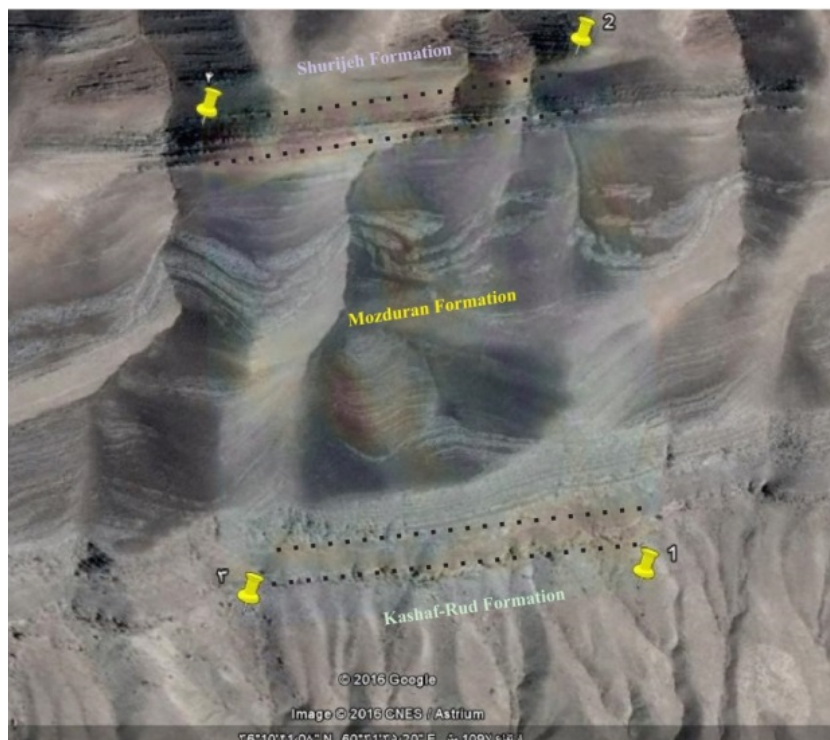


Fig. 5 Correlation magnetite data depicted in an aerial photo

### III. STRATIGRAPHY

Mozduran Formation in east Kopet-Dagh is mainly composed of limestone, dolomite with shale and sandstone interbedded. Based on the characteristics of lithology, it is divided into seven units (Fig. 6). The identified foraminifera and algae are based on [4]-[10].

**Unit 1.** The thickness measurement unit is 30 meters and consists of sandy dolomite and thick bedded dolomite.

**Unit 2.** Consists of dolomite, dolomite limestone with shale inter bedded with thickness of 40.5 meters. The microfossils association, contain numerous species of benthic foraminifera (*Pseudocyclammina lituus*, *Mesoendothyra croatica*, *Alveosepta jaccardi*, *Choffatella* sp., *Lenticulina* sp., *Kurnubia palastiniensis*, *Nautiloculina oolithica*, *Freixialina planispiralis*, *Andersenolina* sp.)

**Unit 3.** The bottom of the unit is thick bedded dolomite and above is dolomite with lamination. The thickness measurement of the unit is 63 meters. Fossils of this unit are: *Mesoendothyra croatica* and *Marssonella* sp.

**Unit 4.** Consists of shale with dolomite interbedded with thickness of 88.5 meters and contains *Choffatella cf. tingitana*, *Ammobaculites* sp., *Alveosepta jaccardi*, *Marssonella* sp.

**Unit 5.** The thickness measurement is 101 meters and consists of thick and middle bedded dolomite limestone. The microfossils of this unit contain; *Marssonella* sp., *Salpingoporella pygmaea*, *Girvanella* sp., *Andersenolina cf. alpina*, *Nodosaria* sp., *Quinqueloculina* sp.

**Unit 6.** Consists of dolomite with shale interbedded and the measured thickness of the unit is 55 meters with fossils of

*Salpingoporella pygmaea*, *Nodosaria* sp., *Salpingoporella* sp.

**Unit 7.** It made of dolomite limestone that the measured thickness of unit is 40 meters. Algae of this unite are *Cayuxia* sp., *Girvanella* sp.

Based on the results of 100 thin section study, 18 genera and nine species of foraminifera and algae (Figs. 7 and 8) were identified. Then, based on index fossils, the age of Mozduran Formation in the east of Upper Jurassic Kopet-Dagh Basin was estimated (Kimmerdgian- Tithonian).

Genus and Species known from the Mozduran formation:

1. *Pseudocyclammina lituus*
2. *Mesoendothyra croatica*.
3. *Kurnubia palastiniensis*
4. *Choffatella cf. tingitana*
5. *Ammobaculites* sp.
6. *Nautiloculina oolithica*
7. *Alveosepta jaccardi*,
8. *Freixialina planispiralis*
9. *Quinqueloculina* sp.
10. *Andersenolina alpine*
11. *Andersenolina* sp.
12. *Lenticulina* sp.
13. *Nodosaria* sp.
14. *Marsonella* sp.
15. *Salpingoporella pygmaea*
16. *Salpingoporella* sp.
17. *Girvanella* sp.
18. *Cayuxia* sp.

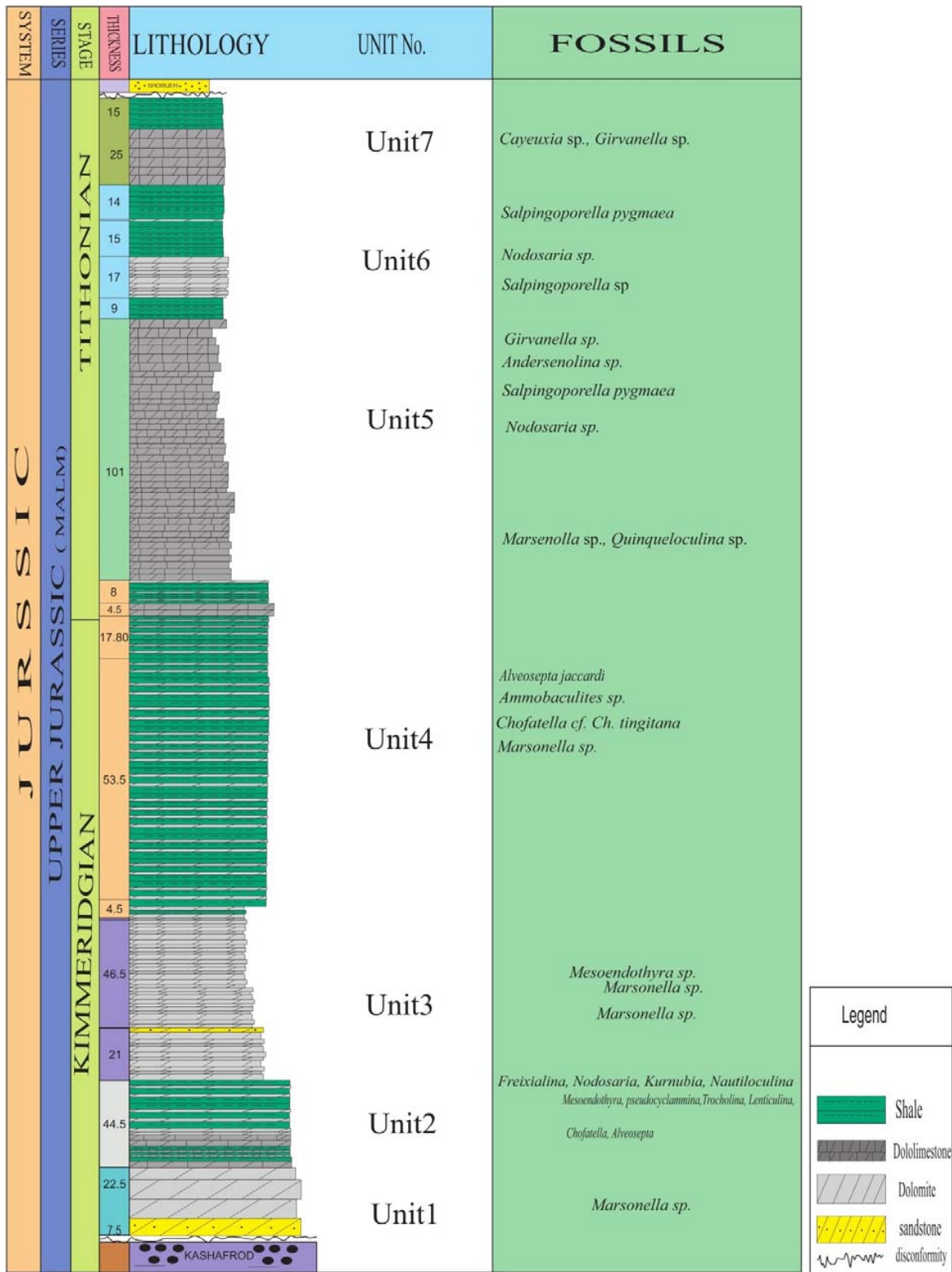


Fig. 6 Stratigraphy column of the Mozduran Formation

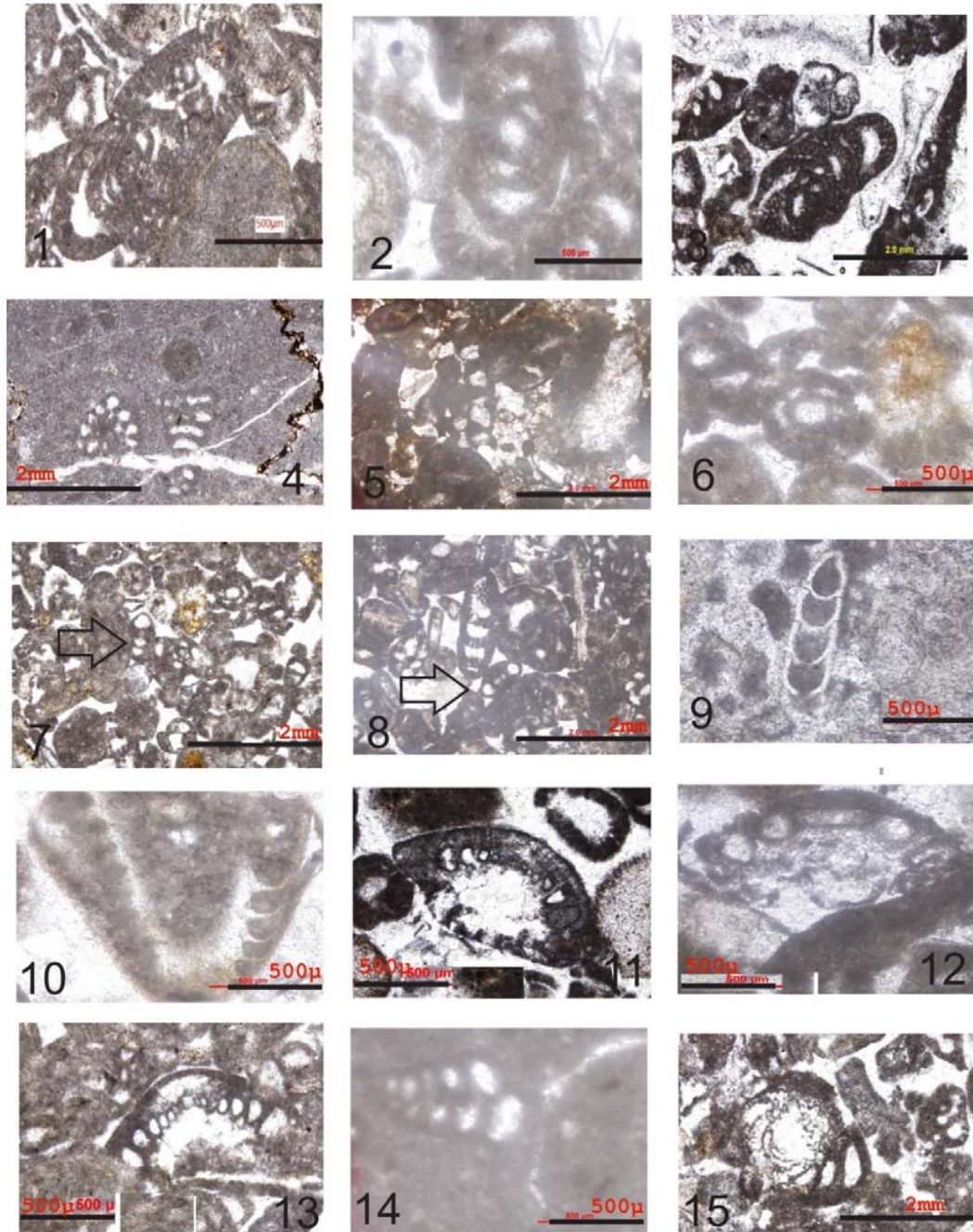


Fig. 7 Foraminifera from the Mozduran Formation: 1-3 *Pseudocyclammina lituus*; (1) sample 14; (2) sample 14; (3) sample 14, 4-5 *Ammobaculites* sp.; (4) sample 37; (5) sample 40, 6-8 *Nautiloculina oolithica*; (6) sample 14; (7) sample 20; (8) sample 14, 9 *Nodosaria* sp.; (9) sample 14, 10 *Andersenolina cf. alpine*; sample 46, 11-13 *Andersenolina* sp. (11) sample 14; (12) sample 14; (13) sample 14, 14 *Marssonella* sp. Sample 20, 15 *Alveosepta cf. jaccardi*; sample 14

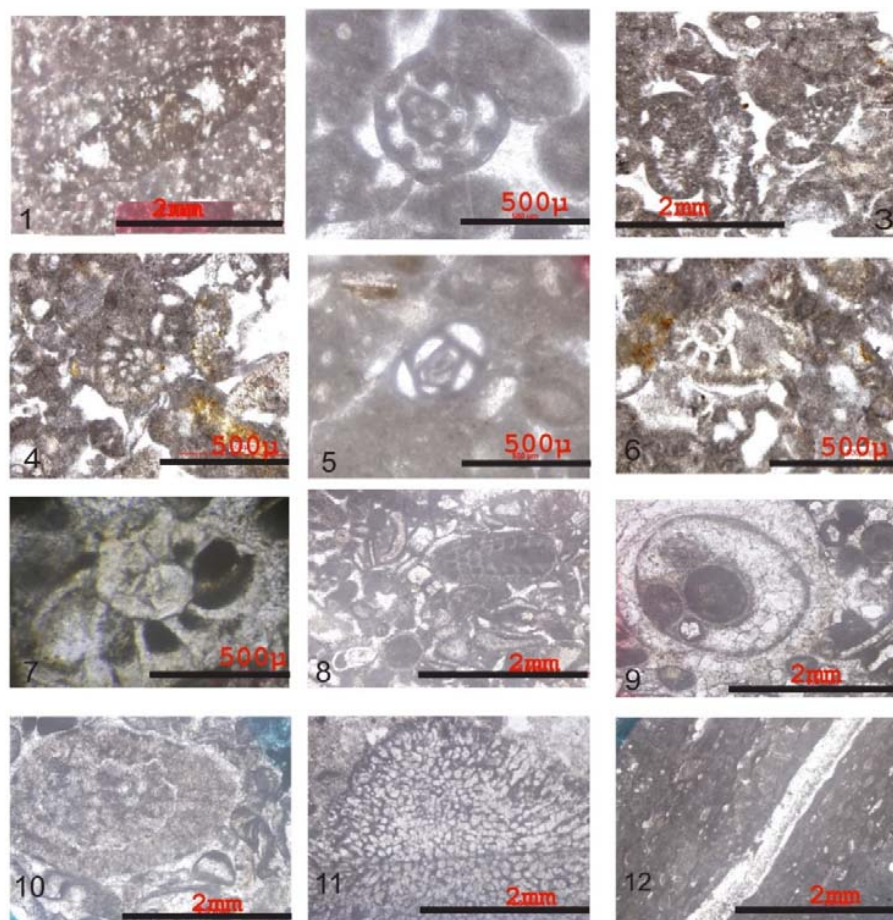


Fig. 8 Foraminifera and Algae from the Mozduran Formation: 1-2 *Mesoendothyra croatica*; sample14, 3 *Kurnubia palastiniensi*; sample14, 4 *Ferixalina planispiralis*; sample14, 5 *Quinqueloculina* sp.; sample20, 6-7 *Lenticulina* sp. sample 50, 8 *Salpingoporella pygmaea*; sample53, 9-10 *Salpingoporella* sp.; sample51, 11 *Cayeuxia* sp.; sample40, 12 *Girvanella* sp.; sample 49

#### IV. CONCLUSION

The Mozduran Formation is in the east Kopet-Dagh basin and is mainly composed of carbonate rocks with inter-beds shale. Moreover, the thickness of the Formation was measured at 418 m. The age of Mozduran Formation base index fossils (example; *Pseudocyclamina lituus*, *Mesoendothyra croatica*, *Kurnubia palastiniensis*, *Nautiloculina oolithica*, *Freixialina planispiralis*, *Andersenolina cf. alpina*, *Alveosepta jaccardi*, *Choffatella cf. tingitana*, *Salpingoporella pygmaea*) was Upper Jurassic (Kimmeridgian - Tithonian). According to description magnetite method, the boundary between the Mozduran Formation and the Kashaf- Rood Formation (low intensity) and the upper boundary of the Mozduran Formation with Shurijeh Formation (high intensity) is disconformity.

#### REFERENCES

- [1] A. Agha-Nabati 2005. The geology of Iran, Tehran University of Iran, pp.75.
- [2] M. Alavi, H. Vaziri, K. Seyed-Emami, Y. Lasemi 1997. The Triassic and associated rocks of the Aghdarband areas in central and northeastern Iran as remnant of the southern Turanian active continental margin. *Geol Soc Am Bull* 109:1563–1575.
- [3] A. Darvish-Zadeh 1991. The geology of Iran, pp. 249.
- [4] J. A. D. Dickson, 1965. A modified staining technique for carbonates in thin section. *Nature*, 205, 587.
- [5] Jr., A.R. Loeblich, H. Tappan, 1988. Foraminiferal genera and their classification. Van Nostrand Reinhold, New York.
- [6] A. Kalantari, Microfacies carbonate rock of Iran, pp. 184.
- [7] I. I., Bucur (1997). Representatives of the genus *Protopenneroplis* (Foraminifera) in the Jurassic and Lower Cretaceous deposits in Romania. Comparisons with other regions of the Tethyan area.
- [8] I. I. Bucur, B. Granier, M. Krajewski. Calcareous algae, Microbial Structures and Microproblematica from Upper Jurassic-lower most cretaceous limestone of southern crimea, *ACTA Palaeontologica Romaniaae* (2014) V. 10 (1 -2), P. 61 -86.
- [9] I. I. Bucur, M. R. Majidifard. B. S. Daryan. Early Cretaceous calcareous benthic microfossils from the eastern Alborz and western Kopet- Dag (Northern Iran) and their Stratigraphic significance, *ACTA Palaeontologica Romaniaae* V. 9 (1), P. 23-37.
- [10] L. Omaña, Late Jurassic (Kimmeridgian) larger benthic Foraminifera from Santiago Coatepec, SE Puebla, Mexico, <https://www.researchgate.net/publication/248616799> (DOI: 10.1016/j.geobios.2008.02.001).
- [11] A. Afshar-Harb, 1979. The stratigraphy, tectonics and petroleum geology of the Kopet-Dagh region, northern Iran.
- [12] A. Afshar-Harb, 1994. Geology of the Kopet-Dagh: Tehran, Geological Survey of Iran, pp. 82-91.
- [13] S., Breiner. 1999. Applications Manual for portable magnetometers. GeoMetrics, 58.
- [14] N. O., Mariita, 2007. The Magnetic Method; Kenya Electricity Generating Company Ltd.