

ویژگیهای ژئوشیمیایی چینه‌های فامنین در ایران (برش میغان) و

مراکش (برشهای مراکب و بو)

نوشته: دکتر سید محمود حسینی نژاد*، دکتر مهدی یزدی** و دکتر قدرت الله ترابی**

Geochemical Characteristics of Famennian Strata in Iran (Meyghan Section) and Morocco (Bou & Mrakib Sections)

By: S.M. Hosseini-Nezhad*, M. Yazdi** & Gh. Torabi**

چکیده

تعدادی نمونه آهنی شده از چینه‌های فامنین ایران و مراکش جمع‌آوری شد. این نمونه‌ها تحت آزمایش فعالیت نوترونی (NAA) واقع شده و برخی اطلاعات درباره تغییرات ژئوشیمیایی پس از رسوب‌گذاری آنها به دست آمد. نمونه‌های جمع‌آوری شده شامل گرهکهای آهنی شده و قطعاتی از بازوپایان، گونیاتیتها و شکم‌پایان از انتهای سازند خوش‌بیلاق در منطقه میغان در ایران و رأس عضو H از برش بو ترفین در مراکش است. بر اساس اطلاعات به دست آمده از آزمایش فعالیت نوترونی (NAA) نمونه‌های جمع‌آوری شده برشهای فوق با هم مقایسه شدند. بر اساس این مقایسه، شباهت گسترده‌ای بین نهشته‌های فامنین ایران و مراکش از نظر ترکیب شیمیایی و عناصر کمیاب (دی اکسید تیتانیم و لوتسیوم) به دست آمد. همچنین تشابه بین شکل، بافت عمومی و جنس بلورها در نمونه‌های هر دو کشور آشکار شد. به نظر می‌رسد بلورهای آهنی در نمونه‌ها، در ابتدای رسوب‌گذاری به شکل پیریت بوده و در نهایت به هماتیت تبدیل شده است. به احتمال زیاد محیط رسوبی در ابتدا ژرف و کم‌اکسیژن بوده و سپس در اثر بالا آمدگی کف حوضه، به یک محیط کم‌ژرفا و اکسیژن‌دار تبدیل شده است.

کلید واژه‌ها: گرهکهای آهنی، میغان، بو، خوش بیلاق

Abstract

Some iron-rich samples from the Famennian strata of Iran and Morocco were collected. The samples were subjected to the neutron activation analysis (NAA) in order to get some information about the geochemical changes after their deposition. The collected samples consist of noduls and remains of brachiopods, goniatites and gastropods from the top of Khoshyeilagh Formation at the Meyghan area in Iran and the top of H-member of Bou Tserfine section in Morocco. Comparison was made between data obtained from the neutron activation analysis (NAA) of the collected samples. Based on this comparison, a broad similarity has been found between the Famennian deposits of Iran and Morocco with respect to their chemical component and trace elements (titanium dioxide and lutetium). There is also a similarity between the shape, general structure and age of crystals in the studied samples of the two countries. Habit of the iron crystals in the samples indicate that iron contents have been preliminarily deposited as crystal of pyrite, which ultimately changed into hematite. This is very likely to be due to the fact that the depositional environment had first been deep and poorly-oxygenated and then changed to a shallow and well-oxygenated environment due to uplifting.

Keywords: Noduls, Meyghan, Bou, Khoshyeilagh

Introduction

The studied area is called Meyghan, where is located 35 Km north of Shahroud city (Figs.1 and 2). In this area, the stratigraphical column of Devonian strata mainly consists of limestone, argillaceous limestone and shale (Fig. 3A). Ahmadzadeh-Heravi et al. (2000) and Hosseini-nejdad and Yazdi (2005) reported iron-rich nuggets from the Famennian strata of Meyghan area. A number of hematitic cephalopods (related to the family of cymaclymeniidae

Hyatt and the species *Cymaclymenia* cf. *pudica*) have recently been collected in Iran (Shotori Mountain Ranges and Meyghan area, Yazdi, 2004). Becker et al. (2002) concluded that the genus of *Cymaclymenia* is restricted to the upper Hembergian (UD IV-B/C). The collected specimens of Meyghan area are ammonoids, brachiopods and gastropods (Pl.1). Most of these specimens have undergone hematitization in the Famennian time. This

phenomena is well-developed in the same horizon in the Khoshyeilagh area, which is located 25 Km northeast of studied area (Fig. 4). Based on the conodont fauna, the age of hematic horizon has been specified as the postera zone. The presence of *Cymaclymenia* and the change of its components into the iron-rich nuggets in the the Famennian deposits of Meyghan area of Iran (Fig. 3A) and Bou and Mrakib areas of Morocco (Figs. 3B, 3C and 6) is probably related to the transgression and regression in the upper Devonian, which corresponds to the Annulata event (Becker *et al.*, 2004).

Methods and sampling

Systematic sampling was used for determining accurate age of Devonian sequences in the Meyghan and Khoshyeilagh areas, the eastern Alborz Mountain Range. The Iron-rich samples (e.g. nuggets and remains of brachiopods and goniatites) were collected from near the top of Devonian strata in the Meyghan area (plates 1 and 2). Herein, it is necessary to point out that the amount of collected iron-rich samples was about two kilograms. These collected samples were analyzed in the laboratory of Iranian Nuclear Energy Organization. The iron-rich samples were collected from Bou and Mrakib areas (Famennian strata) at the time of SDS-IGCP 421 Morocco Meeting (April 23rd-May 1st 1999). Both Moroccan and Iranian samples were analyzed in the laboratory of Iranian Nuclear Energy Organization of Iran.

Results

As pointed out earlier, the iron-rich samples from the Meyghan area of Iran and those of Morocco were analyzed in this research work. The obtained results are presented in Table 1.

As it can be seen in the table 1, the neutron activation analysis (NAA) on the selected samples reveals that the percentages of titanium dioxide and Lu in both Bou and Meyghan areas are similar. By considering the percentages of iron, related iron dioxides and the cubic shape of crystals, it can be suggested that the iron contents have preliminarily been deposited as pyrite crystals and they ultimately changed into the hematite. It can be proposed that there could have been a deeper environment at the Famennian V and a regression happened at the end of Famennian V. Isotope dating should also be carried out on samples in the future to specify the accurate durational time of this changing phenomena.

Discussion

As stated in the previous sections, the collected iron-rich samples from the Meyghan area of Iran and Bou and Mrakib areas of Morocco were analyzed and the results

were compared. An interesting point is that the collected iron-rich samples of Iran and Morocco are made of hematite crystals. On the other hand, the species of *Cymaclymenia* sp. is found in the iron-rich horizon of Famennian deposits in the Meyghan area. The same is true for this iron-rich horizon of Famennian deposits in the Jebel Mrakib of Morocco (Becker *et al.* 1999).

The species of *Cymaclymenia* sp. has been reported from the Famennian strata of Meyghan area by Karimi (2001). In Meyghan area, this ammonoid specimen is associated with the conodont Expansa Zone. The above mentioned ammonoids species has also reported from the Famennian deposits from Kal-e-Sardar in the Shotori Mountain Range (Yazdi, 1999). The presence of this species in Iran and Morocco suggests that the conodont of Expansa Zone has appeared close to the end of Famennian and a deeper depositional environment was prevailed at that time. The frequency of *Cymaclymenia* sp. (Pl.1- Fig. 9) is much more in Morocco (Bou and Mrakib sections) than Iran (Meyghan section). This is presumably related to the different depositional environments in these two countries.

Conclusions

The presence of iron-rich samples (including nuggets and remains of brachiopods and goniatites) in both Iran and Morocco Famennian reveal that the hematitized horizon can be used as a good geochemical marker in the Famennian of Iran and Morocco. Similarity between the trace elements and percentages of iron in the above-mentioned sections confirm that the paleo-depositional environments in these regions have been almost the same (Bou and Mrakib area of Morocco and Meyghan area of Iran). And Morocco and Iran had been located in the northern margin of Gondwana landmass. The shape and form of these iron-rich samples suggest that main source has been pyrite and then they changed from iron trioxide (pyrite) into iron dioxide (hematite). The occurrence of these phenomena indicates that the primary depositional environment had been an anoxic deep environment and then it changed into an oxic shallow depositional environment due to uplifting of sea floor or sea regression. In addition, the phenomenon of changing of an anoxic deep depositional environment into an oxic shallow one is indicative of occurrence of the global Annulata event in the studied regions.

Acknowledgements

Authors would like to thank for the supports made by IGCP 421 Project for sampling in Morocco, specially the supports from Prof. John Talent, Prof. Reimound Fiest and Prof. Elhassani.

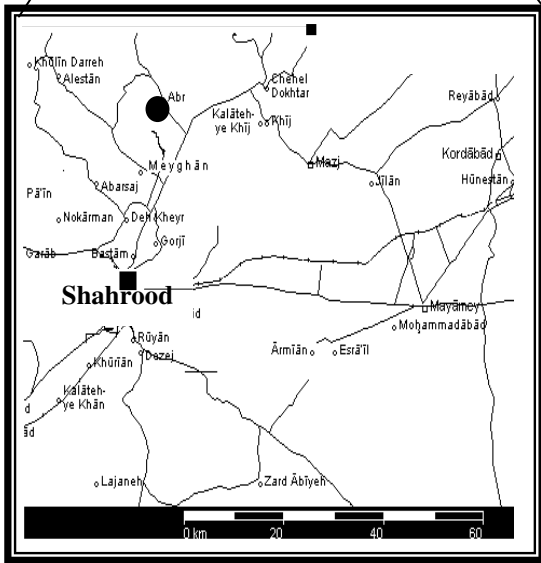


Figure1- Location map of study area



Figure2- Meyghan section



Figure3- Khosh yeilagh section

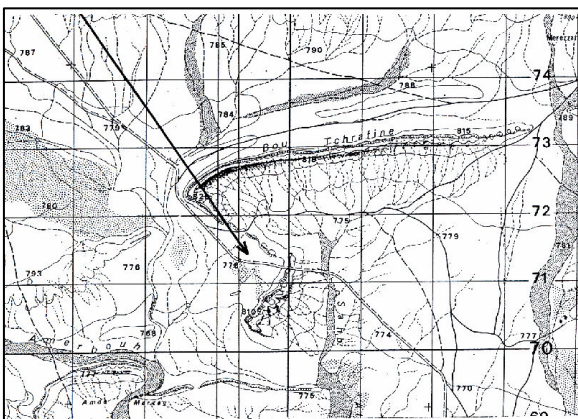


Figure4- Sampled locality of Bou section



Figure5- Bou section

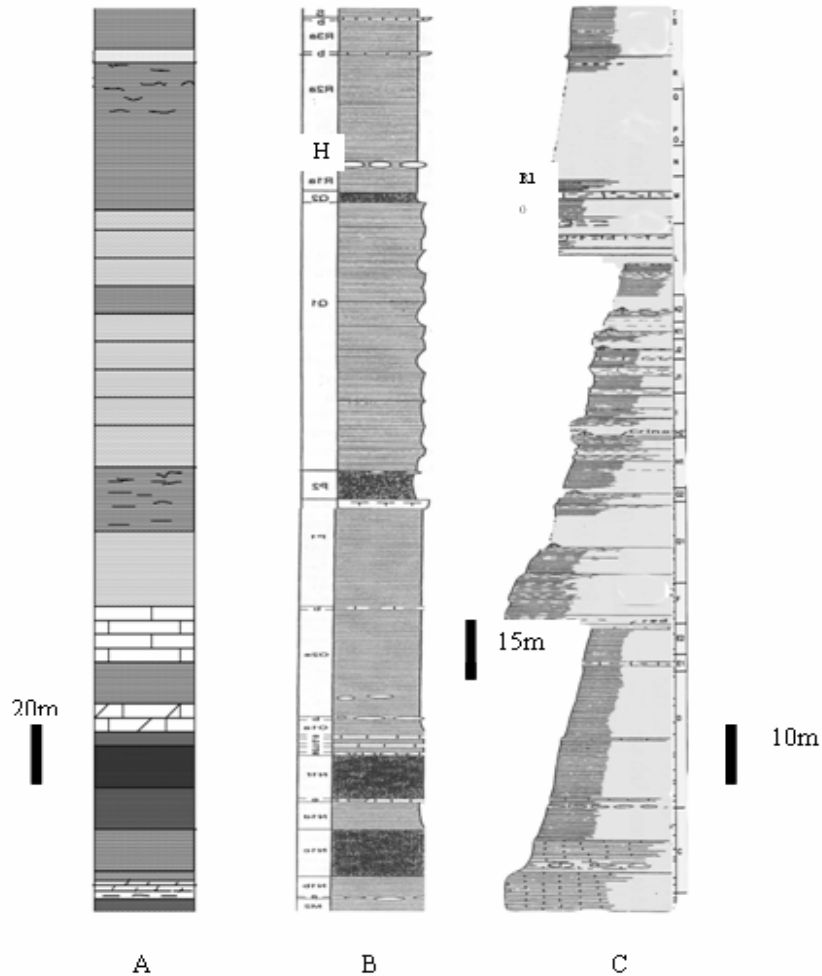


Figure 6– Stratigraphic column of A, Meyghan section ; B, Mrakib section C, Bou section (Figs. B&C; R. T. Becker *et al.*, 2002)

Table 1- neutron activation analysis results of iron-rich samples

Element Country	TiO ₂ %	Al ₂ O ₃ %	Fe ₂ O ₃ * %	MnO (ppm)	MgO %	CaO %	Na ₂ O %	K ₂ O (ppm)
Morocco	0.06	0.13	97.11	0.03	0.47	0.57	0.01	12
Iran	0.06	0.56	92.09	0.01	0.65	0.64	0.02	846

Element Country	Cr (ppm)	Co (ppm)	Sc (ppm)	V (ppm)	W (ppm)	Mo (ppm)	As% (ppm)	Sb (ppm)
Morocco	4	8	5.16	666	0.90	103	0.37	92
Iran	3	15	1.35	13	1.99	26	0.02	179

Element Country	Ga (ppm)	U (ppm)	La (ppm)	Sm (ppm)	Eu (ppm)	Gd (ppm)	Dy (ppm)	Lu (ppm)
Morocco	0.15	4.33	9.13	0.30	1.95	8.50	0.93	0.20
Iran	5.10	2.27	3.17	0.64	0.40	1.00	0.50	0.20



Plate 1

- Fig. 1- Brachiopod shell has been partly changed into iron-rich nuggets.
Fig. 2- Goniatite from Bou section with big crystals (complete changed).
Fig. 3- Goniatite from Bou section (complete changed).
Fig. 4- Orthoceratidae shell from Bou section, Morocco.
Fig. 5- Orthoceratidae shell from Mighan section, Iran.
Fig. 6 and 7- Lophophor of Brachiopod and Brachiopod changed from Iran.
Fig. 8- Gastropod changed from Mighan section, Iran.

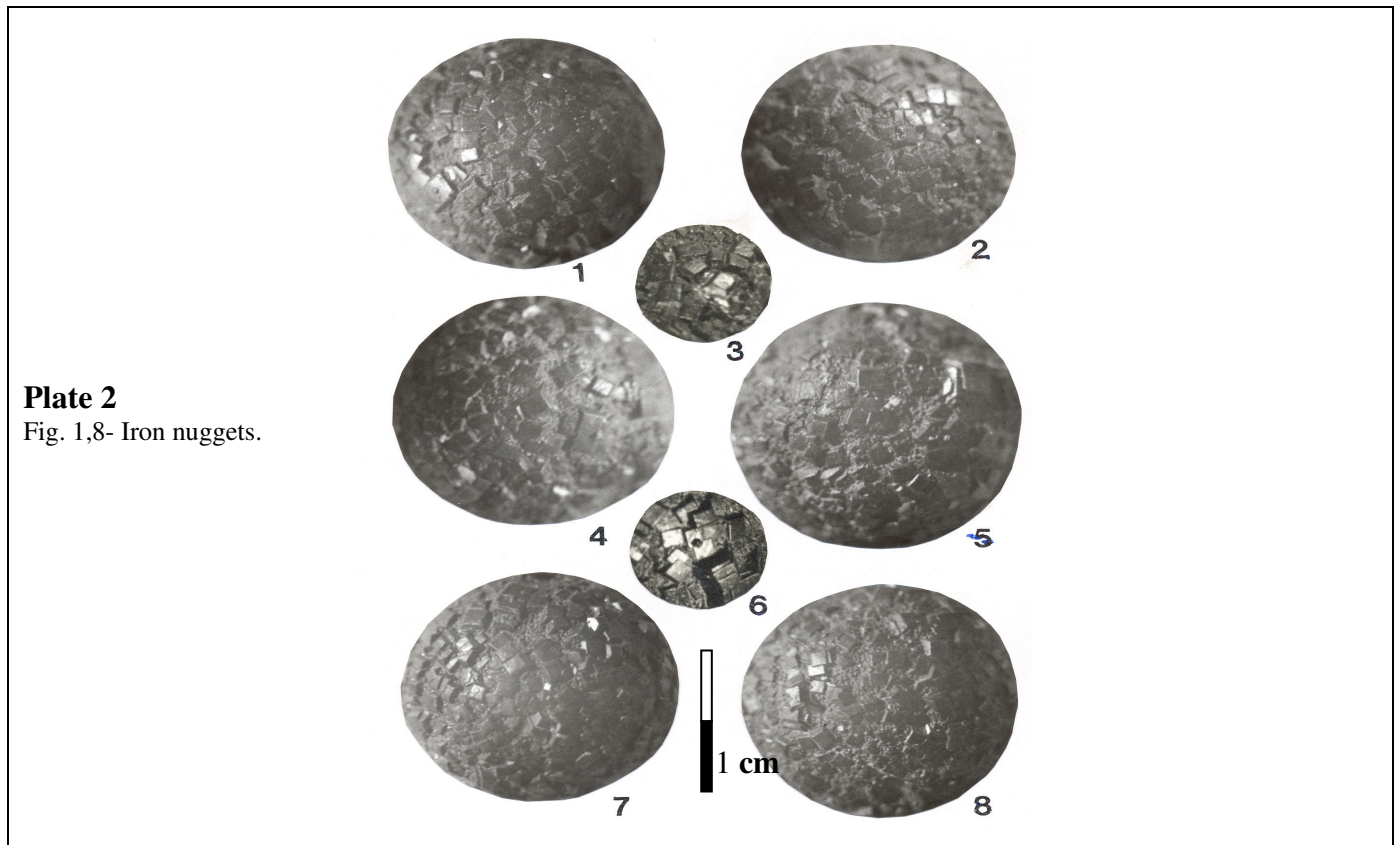
**Plate 2**

Fig. 1,8- Iron nuggets.

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*دانشکده علوم زمین، دانشگاه علوم پایه دامغان، دامغان، ایران

** گروه زمین شناسی دانشگاه اصفهان، اصفهان، ایران

* Damghan University of Basic Sciences, School of Earth Sciences, Damghan, Iran.

**Isfahan University, Department of Geology, Isfahan, Iran.