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Diagenetic stevensite after dolomite in lacustrine deposit of Jbel Rhassoul, Morocco

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ABSTRACT: Stevensite in lacustrine dolomitic deposits of late Tertiary age of Jbel Rhassoul in Morocco is mined for use as fuller's earth. In outcrops, stevensite is disseminated within dolomite layers where it occurs in very irregular lenses. Sedimentary structure, microscopic observation and geochemical modeling suggest formation of the diagenetic stevensite after dolomite.

1 INTRODUCTION

The Tertiary lacustrine formation of the Jbel Rhassoul (Morroco) has great commercial interest because it is exploited for magnesian clays which are used as fuller's earth. The magnesian clays are stevensites which have been described previously (Lucas and Prevot, 1976; Trauth, 1977) but their origin has been unclear. According to the literature, there are several mechanisms to generate stevensite under surface conditions : by direct precipitation from an evaporating saline lake, or by transformation of volcanic ash or diatom frustules. The present work suggests another mechanism, a diagenetic formation of the stevensite after dolomite.

2 GEOGRAPHICAL SITUATION

Stevensite is exploited in the Jbel Rhassoul, on the south-western border of the Missour Cenozoic basin. The Missour basin is the southwestern part of the eastern Meseta, bounded by the folded High Atlas Mountains to the south, the Middle Atlas to the West and north-west, and by the Rekkam cause to the east.

3 GEOLOGICAL SETTING

During the Mesozoic, sedimentation was very discontinuous, with numerous hiatuses in the region, showing lagoonal and evaporitic facies. In the early Tertiary, the structural partition progressively increased, owing to the upthrow of the Atlas mountains range, whereas the Missour basin underwent a slow subsidence. Along the borders of that "mountain basin" very large fan deltas of coarse detrital material were prograding into a lacustrine basin having carbonate, marl and salt deposits.

4 FACIES MODEL

Two fan-deltaic environments followed one another. The first and oldest delta, which is not shown in the figure, consists of very large, well developed alluvial fans that prograde into an evaporitic playa. These deposits never contain stevensite or dolomite. The younger delta, is an alluvial fan prograding into a lacustrine environment which is characterized by dolomites containing characeae near the littoral line, and by marly salt layers in the centre of the basin (Figure 1). Stevensite is strictly confined to the dolomitic facies, where it occurs in discontinuous lens-shaped seams. These stevensite veins generally are associated with flint nodules or flint banks.

5 DIAGENETIC STEVENSITE AFTER DOLOMITE

5.1 Sedimentologic arguments

The stevensite seams disappear toward the shore of the lake and toward the centre of the basin, as does

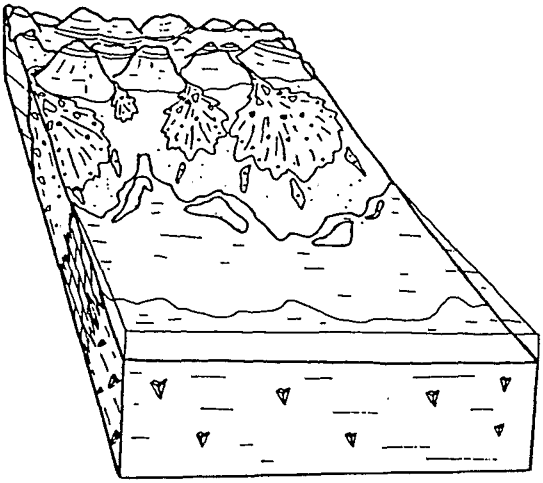


Fig.1 Facies model. Stevensite is strictly confined within the dolomite facies in which it occurs in discontinuous lens shaped seams

the dolomite with which it is tightly linked. Moreover, there are no real veins of stevensite, but instead there are gradual continuous passages from the dolomite to the stevensite. Clearly, there is no sedimentary contact between the minerals, but a gradual continuum. These observations suggest a diagenetic transformation of dolomite into stevensite.

The arguments supporting the diagenetic development of stevensite are based on the sedimentary structures. In places, the dolomites are characterized by numerous root pipes, stems of characeae and algal crusts. These structures are typical of the dolomitic deposits in this basin, and can be found sometimes entirely preserved in the veins of stevensite. Most of these tubes, which often are very long, can be followed vertically from the dolomite through the stevensite veins. When a dolomite contains flint, the dolomite is transformed into an argillaceous bed with flint nodules (Figure 2)

5.2 S.E.M Morphological arguments

On the microscopic scale (S.E.M), the diagenetic replacement of dolomite by stevensite, preceeded possibly by dolomite epigenesis (Figure 3). Dolomite having a rose shape, showing the growth of dolomite in place, has been dissolved, and stevensite having honeycomb shape has recrystallised in its place. When the dolomite is absent, the stevensite occurs in thick mats.

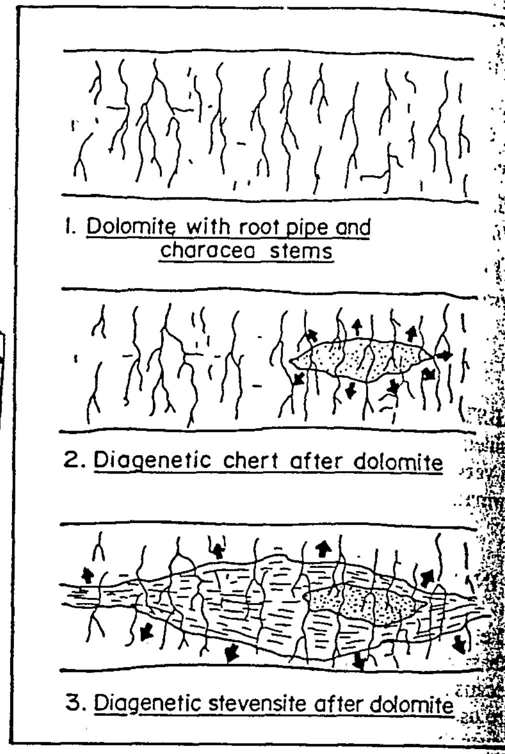


Fig.2 Diagenetic chert and stevensite after dolomite, showing preserved sedimentary and biological structures

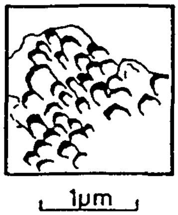
5.3 Geochemical modeling

Waters which drain the region around Jbel Rhassoul were sampled. The paleogeography of the Jbel Rhassoul region was similar to that of the present day. Therefore, the sampled water may be similar to those that filled the lake in which stevensite was deposited. With the help of EQUIL, EVAPOR and DISSOL codes (Fritz, 1981), and using temperatures equal to 25°C, the analysed waters (Tab.1-a) were modelled for stevensite formation after dolomite.

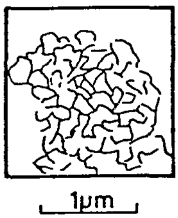
The code EQUIL shows supersaturation of the water with respect to dolomite. The code EVAPOR, applied to these waters, shows the dolomite precipitation by evaporation. After dolomite precipitation, waters are poor in Mg and Ca, and are silica-rich (Tab.1-b)

The code DISSOL shows that stevensite formation is possible by reaction between dolomite and the waters conserved by evaporation, but diluted twice (Tab.1-c).

The geochemical modeling allows us to



1. Precursor dolomite having a rose shape



2. Diagenetic stevensite with a honeycomb shape replacing dolomite

3. The stevensite occurs in thick mats

Fig.3 Process of formation of diagenetic stevensite after dolomite on microscopic scale (S.E.M)

propose a model for the formation of diagenetic stevensite after dolomite under a variable climate. In the late Tertiary, the Jbel Rhassoul lake was filled by the waters in which the Mg and Ca contents were much higher than the Si content. Under a drier climate, after evaporation, these waters become more concentrated in Ca and Mg. Dolomite precipitated the water became enriched in Si. Later, under a wetter climate, the waters became diluted ; the result was a dissolution of dolomite followed immediately by crystallisation of the stevensite.

6 CONCLUSION

The very irregular shape of the stevensite deposits, and their occurence in the dolomite, clearly

Table 1. Composition of solutions

EL^T mmoles/l	(a)	(b)	(c)
K	0.19	0.25	0.17
Na	5.84	33.65	23.01
Ca	3.92	1.28	0.86
Mg	3.87	1.22	0.55
Si	0.15	0.33	0.22
Al*	0.1	0.21	0.14
S	4.40	9.34	6.26
Cl	8.42	17.87	11.98
Alkal.	4.92	2.34	1.57
pH(25°C)	8.05	7.94	7.94

(a) Composition of initial solution
(b) Composition of solution after evaporation
(c) Composition of solution after evaporation and dilution (twice)

* Al is considered equal to 0.1 µmol (value just less than detection limit)

preclude a direct precipitation from an evaporating saline lake. Authigenic stevensite on diatom frustules or volcanic ash is unlikely because of the total lack of any traces of such components. Therefore, the evidence, which includes the observation of sedimentary structures, of S.E.M morphological textures and the geochemical modeling suggest a new mode for diagenetic stevensite formation after dolomite in a lacustrine environment.

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