The study of chert nodules in the Sardar Formation, Ozbak-Kuh Mountains (North Tabas)

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Abstract

The aim of this study is to analyze chert nodules in the Carboniferous sediments (Sardar Formation) in South of Ozbak-Kuh (North Tabas). In this area, cherts occur as irregular nodules in the bioclastic wackestone and packstone. These chert nodules are avoid and bowl-shaped with clear lateral contacts. The color of nodular cherts is dark gray and black due to impurities such as organic matters and relic of carbonates. These cherts commonly contain relic component of other carbonate grains such as dolomite. The host rocks of all chert nodules in this study are biomicrite (skeletal wackestone and packstone). Dolomite rhombohedra are present within chert nodules but there is no evidences that the nodular cherts formed by the replacement of a dolomite precursor. Ghost of skeletal grains, such as crinoids, are preserved in the chert nodules and show diagenetic origin. Chert nodules have various forms but their longer dimension is parallel to bedding strikes. Based of petrographic studies, four fabric types are distinguished in silica including microcrystalline quartz, megaquartz (mosaic quartz), chalcedony overlay and spherulitic chalcedony.

Key words: *Chert nodules, Carboniferous, Ozbak-Kuh, Sardar Formation*

Introduction

Chert is a hard, dense or compact siliceous rock, consisting of micro or cryptocrystalline quartz crystals that contain impurities such as carbonate, iron oxides and organic matters. The purpose of this study is to analyze chert nodules in the Carboniferous sediments (Sardar Formation) in North Tabas (Fig.1). Chert can provide a window to the original composition of the sediment, the diagenetic history and the biota of the host rock due to its low susceptibility to further daigenetic alterations (Maliva, 2001). In this area, chert replaced limestone as nodules, thin layers and irregular masses. The form of the replacement is probably controlled by the porosity-permeability distribution of the carbonate, the hydrologic flow, and various factors affecting nucleation (Knauth, 1979). Chert nodules in limestone rocks have been documented in a variety of geological settings. These nodules formed during early diagenesis and are common in pelagic chalky limestones (Zijlstra, 1987) as well as shallow marine settings, where they are related to mixing zones (Geeslin and Chafitz, 1982).

In this Area, chert nodules are as potato and avoid shaped with several centimeters in diameter with conchoidal fracture and replacing the host rock along bedding planes (Fig.4a). The color is commonly dark gray and black due to impurities such as organic matters and relic of carbonates. Nodular cherts might grow outward from a nucleation site. Most specimens of chert nodules occur in biomicrites. In thin section, chert nodules

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display a large range of petrographic textures that are related to the manner in which they formed and burial history (Hesse, 1989, 1990; Carozzi, 1993). The thin sections have been stained by alizarine R-S and also studied by SEM and EDX. The degree of silicification is variable, for example from nearly complete with slightly inclusions of carbonate minerals to uncompleted as mixed of microquartz and microspars.

Small carbonate rhombohedra are commonly present in chert nodules examined (Fig.4b). Ghosts of carbonate or skeletal grains precursors in chert nodules clearly show that most chert nodules formed from replacement of carbonate rocks. One important relationship observed under the microscope is between silicification and compaction. In the sectors of thin section, skeletal grains are completely replaced by silica and another sector unsilicified or partially silicified carbonate grain have a deformation that occur due to compaction.

Mineralogy of carbonate rhombohedra

Using staining and EDX analysis, rhombohedra are dolomite that shows zoning (Fig.2). Based on EDX analysis, dark line in zones of dolomite is organic carbon (Fig.3). Figure 2 show SEM views of dolomite grain and the EDX spectrum indicates the presence of all major elements typical of dolomite (Ca and Mg). In this example, the peak height of Mg is similar to Ca.

Classification of silica texture in chert nodules

On the basis of their morphology, four major fabric types are identified:

1- Mega Quartz and Mosaic quartz

Mega quartz is coarse grain (>20μm), when the grain size increases towards the inner side of the pore, it gives a drusy texture. Mosaic quartz is similer to drusy quartz (Fig.4c). This usually is colorless and may contain inclusions. They are equigranular anhedral grains; grain size progressively increases from the margins to the center (similar to drusy calcite). Extinction is commonaly uniform and irregular extinction occurs where the fabric merges into chalcedony.

2- Chalcedony overlays

This fabric is commonly colorless with shades of brown and usually forms rims around silicified allochems (Fig.4d). In crossed nicoles, it appears as fibrous and each fiber having an extinction position approximately normal.

3- Spherulitic Chalcedony

This fabric is colorless with shades of brown and concentric bands of inclusion that are sometimes developed within some spherulites (Fig.4e). Chalcedony quartz is often a pore-fill rather than replacement. This is supported from the evidence of the sample illustrated; in that there are straight boundaries are characteristic of radial-fibrous and pore-filling cements (Adams et al., 1984).

4- Microcrystaline granular quartz

This fabric is colorless with slightly inclusion and is common showing patchy distribution. They are fine grained (< 20μm) and equigranular texture (Fig.4f).

This quartz replaces micrite grains. Clotted fabric in Figure 9 indicates that chert is associated with microbial structures. It shows that the organic matter would be acted by adsorbing the silica in the fluid (Raviolo et al., 2009). This occurs in the case of silicification during early diagenesis, when the bacterial activity and oxidation of the organic matter are still active (Gao and Land, 1991).

Conclusion

In Sardar Formation, chert nodules are varied in shape but they are discoid or egg-shaped masses with size ranges from a few centimeters to a few tens of centimeters. They commonly concentrated along bedding strike. Irregular shape, presence of irregular patches of carbonate and presence of silicified fossils in some nodules are evidences for a replacement origin.

In chert nodules from Sardar Formation, dolomite rhombohedra were always found that contain zoning. Due to presented dolomite rhombohedra in the chert nodules and absent in the surrounding carbonate rocks, they are clearly showing evidence of diagenetic origin. Under microscope, silica in nodular chert show different types of fabrics that is micro quartz mainly replaced carbonate grains, the megaquartz and spherulutic chalcedony are mainly envity filling cements.

References

1- Adams, A.E., Mackenzie, W.S., and Guilford, C., 1984, Atlas of sedimentary rocks under the microscope, Longman, 104p.

2- Carozzi, A.V., 1990, Sedimentary Petrography, Prentice, Hall.

3- Gao, G., and Land, L., 1991, Nodular chert from the Arbuckle Group, Slick Hills, SW Oklahoma: a combined field, petrographic and isotopic study, Sedimentology, v.38, p.857-870

4- Geeslin, J.H., Chafetz, H.S., 1982, Ordovician Aleman ribbon cherts: an example of silicification prior to carbonate lithification, Journal sedimentary petrology, v.52, p. 1283-1293.

5- Hesse, R., 1989, Silica diagenesis: origin of inorganic and replacement cherts, Earth Science Reviews, v. 26, p. 253-284.

6- Hesse, R, 1990, Origin of chert and silica diagenesis. In Mellreath, I.A., and Morrow, D.W, (eds.), Diagenesis. Geological Association of Canada. Geoscience Canada Reprint Series 4, pp. 227 – 275.

7- Knauth, L.P., 1979, A model for the origin of chert in limestone, Geology, v. 7, p. 274-277.

8- Maliva, R.G., 2001, Silicification in the Belt Supergroup (Mesoproterozoic), Glacier National Park, Montana, USA, Sedimentology, 48, 887-896.

9- Raviolo, M.M., Barbosa, J.A., and Neumann, V.H., 2009, characteristic, distribution and diagenetic stages of chert in the La Silla Formation (Lower Ordovician), Argentine Preandillera, An Acad Bras Cienc, v.81, no.4, p.781-792.

10- Zijlstra, H.J.P., 1987. Early diagenetic silica precipitation, in relation to redox boundaries and bacterial metabolism, in Late Cretaceous chalk of the Maastrichtian type locality. Geol. Mijnbouw, 66:343-355.

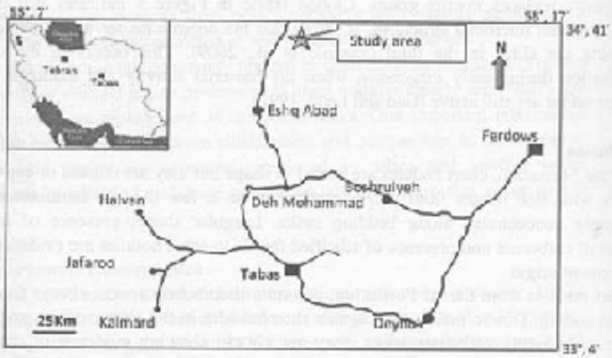

Fig.1- The location map of study area

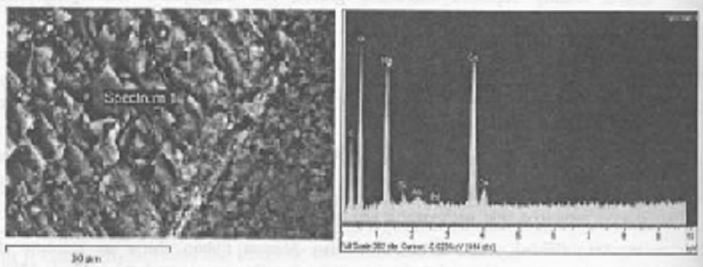

Fig.2- SEM view and EDX spectrum of carbonate rhombohedra.

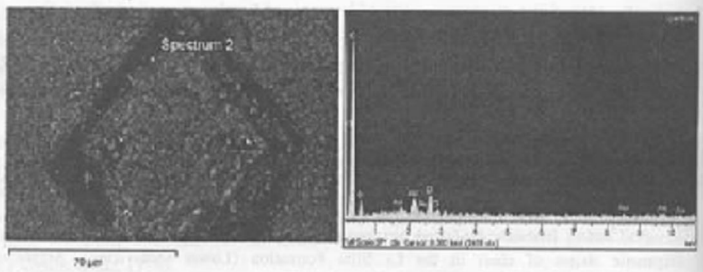

Fig.3- SEM view and EDX spectrum of dark line in zoned dolomite.

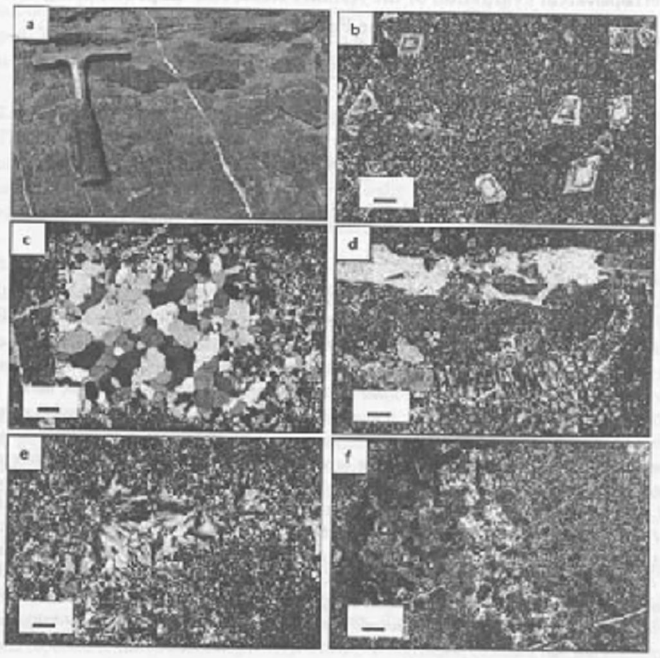

Fig.4– (a) Chert nodules in Sardar Formation (Ozbak-Kuh). (b) Euhedral dolomite rhombs in chert, XPL. (c) Mosaic quartz, cavity filled by mega quartz, drusy texture, XPL. (d) Chalcedony overlay, XPL. (e) Spherulitic chalcedony associated with dolomite rhombohedra and microcrystalline quartz, XPL. (f) Microcrystalline granular quartz associated with patchy of organic materials, XPL.