# Silicification of Carbonate Rocks of Chehel-Kaman Formation (Upper Paleocene) in the West of Kopet-Dagh Basin, NE Iran

Akbar Heidari, Asadollah Mahboubi and Reza Moussavi-Harami

Department of Geology, Faculty of Science, Ferdowsi University of Mashhad
E-mail address: heydari.1982@ yahoo. com

**Abstract**

*Several diagenetic processes, which one prominent process is silicification, affected the Upper Paleocene carbonate rocks of Chehel-Kaman Formation in the Western Part of Kopet-Dagh basin (NE Iran and S Turkmenistan). The aim of this study is classification and interpretation of diagenetic processes and environments for mentioned different silicification types. Five types of silicification are recognized in this study that formed in three diagenetic phases. Based on appearance and the place of silicification, two models (Immediate and late) for silicification interpreted. Silicification happened in three forms including micro and macro quartz as well chalcedonies. Micro types formed as cement and voids filler and, do not follow any regular pattern. Macro types precipitated as four different fabric. First type filled vacant voids between allochems in void grainstone facies that we have interpreted as oolitic shoals. This type is not fabric selective but can be commented facies selective. Second macrotype, formed in fractures and intersect the texture of the carbonate rocks. It is formed in a wide range of facies. Third type of macrotype has seen as macroquartz that occurred in deepest facies. Last feature of silicification is chalcedonic type that formed as fabric selective. This type precipitated in brachiopods and some bivalve shells with foliated fabric. Silicification of the carbonate rocks may have been taken place under acidic conditions (pH<7). In this conditions quartz precipitate and carbonate dissolved and provide appropriate space for next phase of silicification. Based on the diagenetic processes, formation of quartz and chalcedony refer as mixed (Eogenes phase precipitated some of microquartz type), burial (mesogenes that deposited some micro-macro quartz and chalcedonic types) and uplifting zones (telogenes phase that some macroquartz type spread fracture type formed in it).*

**Key Words:** *Silicification, Carbonate Rocks, Chehel-Kaman Formation, Diagenetic.*

## Introduction

The Kopet-Dagh Intracontinental Basin situated in northeastern Iran and southern Turkmenistan. This Basin Formed after (Berberian and King,, 1981; Ruttner, 1993). Relatively continuous sediment deposition took place from the Jurassic through the Neogene time in the Kopet-Dagh basin (Afshar-Harb, 1994). The thickness of these sediments in the basin portion reached up to 8 km (Afshar-Harb, 1994), while in Turkmenistan it may have reached up to 15 km (Lyberis and Manby, 1998). The early Paleocene regression followed by a transgressive of the sea and deposition of marine sediment of the Chehel-Kaman formation that overlies Pestehleigh Formation. The basin folded during the Late Alpine compressional events and created many anticline traps such as those that contain the Khangiran and Gonbadli gas field, in northeast Iran (Moussavi-Harami and Brenner, 1993). One of the diagenetic processes that affect carbonate rocks of Chehel-Kaman Formation is silicification. The objective of this study is detail consideration of the processes including various stages of Formation and diagenetic environment. Two stratigraphic sections including Gerish and Jowzak in the west Kopet-Dagh basin measured and sampled (Fig. 1) and 50 saimed thin sections have studied.

## Discussion

Silicification is a diagenetic process that can be helpful and sort some problems out such as amount and concentration of silica in diagenetic fluids and time of silicification than other diagenetic processes (Hess, 1990). Silicification and its replace in carbonate rocks needs high concentration of silica (Maliva and Siever, 1988). Silicification is a plenty process but replacing mechanisms are not completely understood (Daley and Boyd, 1996).

Silicification of carbonate rocks of Chehel-Kaman Formation performed in five different types in study area. Three features have seen in one facies (Bioclastic Floatstone). The first type (major type of silicification) carried out in deepest facies of studied interval that is known as Bioclastic Floatstone facies ($D_4$) (Heidari, 2007) (Fig. 2A, B). It is fabric selective are affected partial brachiopod shells and appeared as chalcedonic forms (big spheroids), but other allochems such as bivalve clasts are not silicified and they recrystalized by blocky calcite. Foliated microstructure is main fabric of brachiopod shells and this microstructure can be effective and increase permeability and transfer of diagenetic liquid (Daley and Boyd, 1996). As a result, foliated fabric can be responsible for this kind of silicification. Second type of silicification also occurred in Bioclastic Floatstone ($D_4$), but it formed in a different feature as microquartz type in the matrix of facies (Fig. 2C). The size of silica crystals range from 1-2 µm and categorized as microquartz type. It filled voids and some parts of primary void are vacant yet that is a good evidence for prove a dissolution phase prior type 2 of silicification.mThird type is resemble to previous type and formed in vacant voids in D4 facies, but the size of them is range from 2-3 mm and categorized as macroquartz type. Forth type of silicification is facies selective and occurred just in dissolution voids between ooids in limestone facies (Fig. 2D). Finally last type occurred in fractures (Fig. 2E), and in some cases crossed type one that could indicates precipitation of this type after it (Fig. 2F).

Dissolution of calcite and consequently silicification occurs in two different stages including immediate and late (Schmit and Boyd, 1981). In Immediate stage there are some remains of silicified allochems and there is no any trace of dissolution (pattern 5 from Schmit and Boyd, 1981), but in late silicification, there are some voids those formed in previous phase and silica fill some of them (pattern 1 to 3 from Schmit and Boyd, 1981). Based on petrographic studies in this case study, there are immediate and late stages of silicification in Chehel-Kaman's carbonate rocks:

A) Marine Model supposed for type 1 (immediate): this model appears as chalcedonies and replaced in brachiopod shells. Some evidences of immediate silicification in this type are selective silicification, remain parts of silicified shells and there is no any dissolution in silicified brachiopod shells that reinforced the immediate theory for type 1.

B) Mixed Zone (marine and meteoric) to shallow buries for types 2, 3, 4 and 5 (Late): these four types often have grown in vacant voids. Therefore, silicification carried out after an extensive dissolution that supplied appropriate space for next process (silicification).

C) Final (After uplifting) for type 5. This type of silicification crossed other types and developed in fractures, which could indicate it carried out after uplifting.

## Conclusion

Silicification is a prominent digenetic process that appeared in five different types in Chehel-Kaman carbonate rocks. Petrographic studies lead to interpretation of three diagenetic stages including immediate (marine), late (burial), and final (after uplifting).

## References

1. Afshar-Harb, A., 1994, Geology of Kopet-Dagh, The Project of Compiling of Geology of Iran's Books, Ministry of Industries and Mine Geological Survey of Iran, 275pp.

2. Berberian, M., and King, G.C.P., 1981, Toward a paleogeography and tectonic evolution of Iran, Canadian Journal Earth Sciences, v. 18, p. 210- 265.

3. Daley, R.L., and Boyd, D.W., 1995, The role of skeletal microstructure during selective silicification of brachiopods. Journal of Sedimentary Research, v. 65, no. 1, p. 155-162.

4. Hesse, R., 1990, Silica diagenesis, origin of inorganic and replacement cherts. In, Mcllreath, A. Morrow, D.W. (Editors), Diagenesis. Geoscience Canada, Reprint Series, 4, Canada, p. 253–275.

5. Heidari, A., 2007, Interpretation of Sedimentation History and Sequence Stratigraphy of Pestehleigh and Chehel-Kaman Formations in the West of Kopet-Dagh Basin, NE Iran, Ferdosi University of Mashhad, Iran, M.Sc Thesis, 375 pp.

6. Maliva, R. and Siever, R., 1988, Pre-Cenozoic nodular cherts, evidence for opal-CT precursors and direct quartz replacement, Am. J. Sci, v. 288, p. 799-809.

7. Lyberis, N. and Manby, G., 1998, Post-Triassiev evolution of the southern margin of the Turan plate, C. R. Acad. Sc., v. 326, p. 137-143.

8. Moussavi-Harami, R. and Brenner, R.L., 1992, Geohistory analysis and petroleum reservoir characteristics of Lower Cretaceous (Neocomian) Sandstone, eastern portion of Kopet-Dagh basin, northeast Iran, American Association of Petroleum Geologist Bulletin, v. 76, p. 1200-1209.

9. Moussavi-Harami, R., Brenner, R.L., 1993, Diagenesis of nonmarine petroleum, reservoir the Neocomian (Lower Cretaceous) Shurijeh Formation, Kopet-Dagh basin, NE Iran, Journal Of Petroleum Geology, v. 16, no. 1, p. 55-72.

10. Ruttner, A.W., 1993, Southern borderland of Triassic Laurasia in northeast Iran. Geol. Rund, v. 82, p. 110-120.

11. Schmit, J.G., and Boyd, D.W., 1981, Patterns of silicification in Permian pelecypods and brachiopods from Wyoming. Journal of Sedimentary Petrology, v. 51, p. 1297-1308.

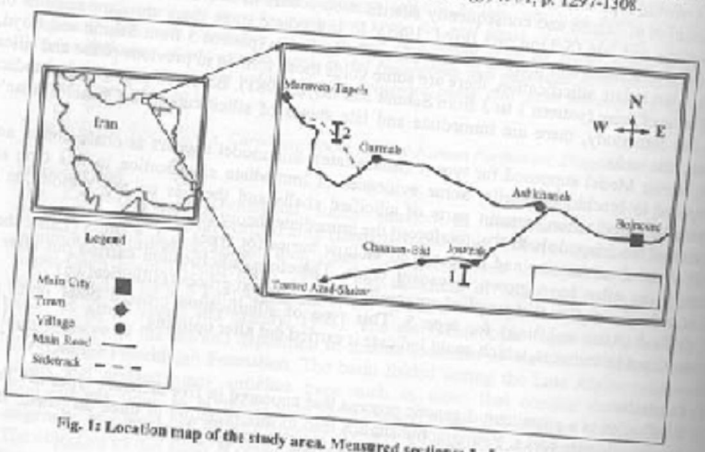


**Fig. 1: Location map of the study area. Measured sections: 1- Jowzak; 2- Garmab.**

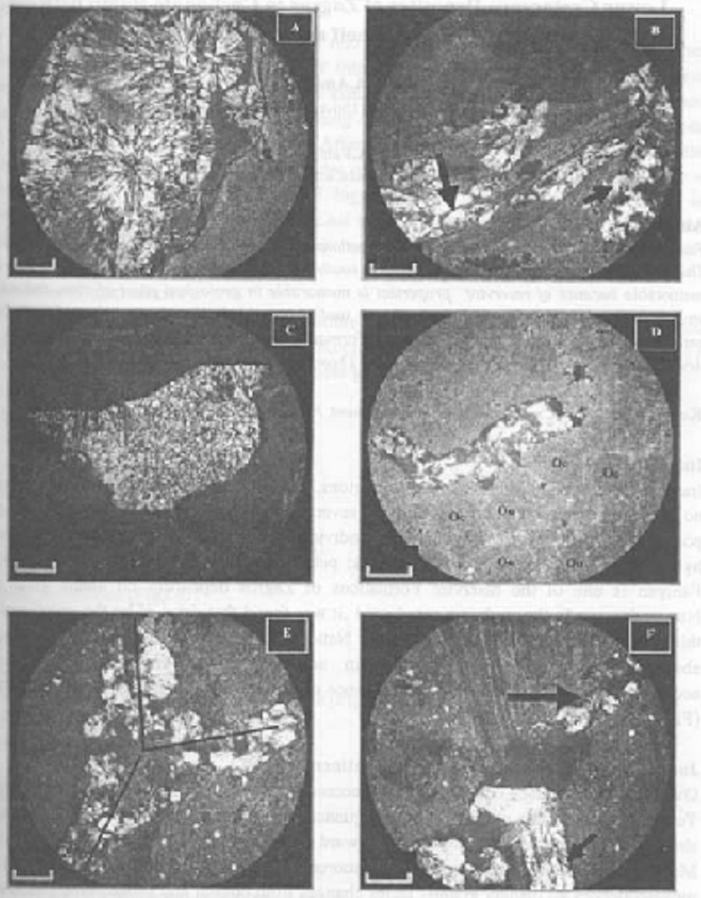


Fig. 2: Silicification process in carbonate rocks of Chehel-Kaman Formation. A) Type 1, chalcedonies replaced in brachiopod shell. B) Type 1 and 2: bigger arrow shows chalcedony and smaller arrow shows macro quartz in vacant void; C) Type 3: micro quartz solution void; D) Type 4: facies selective macro quartz that formed in solution voids in Oolid grainstone; E) Type 5: micro quartz formed in fractures in three different directions; F) Type 1 and 5: type 5 crossed brachiopod shell and its silicification, bigger arrow shows type 5, smaller arrow shows type 1.