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Statistical analysis of the chemical facies of the Qom Formation in the southwest of Saveh, Iran.

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Abstract

This study investigates the chemical facies and geochemical characteristics of the detrital units of the Qom Formation located southwest of Saveh, Iran.

The study area is part of the 1:250,000 geological map of Qom and is located southwest of Saveh County in Markazi Province.

Using a combination of geochemical and mineralogical analysis methods, this study identifies nine distinct chemical facies, which are characterized by their unique elemental ratios and mineral compositions.

Analysis methods include X-ray fluorescence (XRF) and loss on ignition (LOI) tests.

Examination of the nine identified facies shows that high values of K/Al, Fe/Al, Ti/Al, Mg/Al can be found in facies 1-4. Low values of Fe/Al, K/Al, Si/Al can be detected for facies 5 and 6. In facies 8-9, high Fe/Al, Mg/Al and K/Al ratios are observed.

In facies 1-4, mineralogy related to micaceous clays, rutile, hematite and dolomite can be detected, in facies 6 and 7 mostly micaceous clays, granite and feldspar, and in facies 8 and 9 mostly granitic origin, potassium basalt and the presence of hydroxides can be recognized.

This classification allows for accurate inferences about the origin, weathering and diagenetic processes of formation of the rock units of the study area.

Introduction

The studied area is a part of the 1:250000 geological map of Qom and is located in the southwest of Saveh city in Central province. The studied area is a part of central Iran and Tabriz-Bazman or Sahand-Bazman volcanic belt (Darvishzadeh, 2001). This region has a geographic longitude of 49 57 and 34 59 degrees (Fig 1). The Qom Formation is formed in the marine basin on the northern margin of the Tethys Sea (Harzhauser & Piller, 2007).

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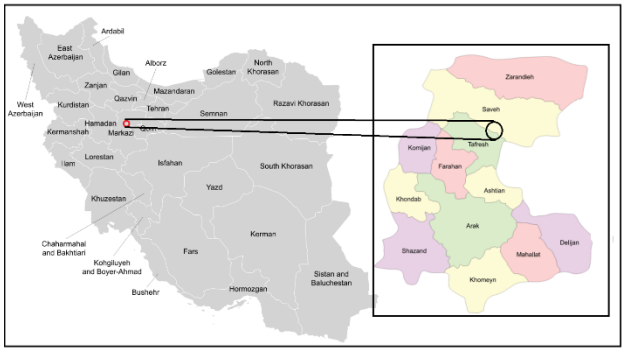

Figure1. Location of the study area

Qom sea basin is divided by Mohammadi et al. (2013) into three sub-basins: Qom back arc, Urumieh-Dokhtar Magmatic Arc (UDMA) and Isfahan-Sirjan back arc. Soder (1955), who established the type locality near the town of Qom and defined six lithostratigraphic units (a-to f-Members: a-Member = basal limestone, b-Member =sandy marls, c-Member = alternating marls and limestones, d Member = evaporites, e-Member = green marls, f-Member = top limestone). Whereas Bozorgnia (1966) recognized two sedimentary cycles in the Qom Fm. At its type area, Nogol-Sadat (1985) identified a third sedimentary cycle. During the oil discoveries of the Qom Formation in the south of Qom (Gansser, 1955 and Former and Sudar, 1955), six lithological units (A-F) were specified in this format. Furrer and Suder (1955) divided the Qom Formation into five members (a-f members) and introduced the mountains in the vicinity of Qom as type locality.

Bozorgnia(1966), while studying the stratigraphy of this formation, noted that the greatest extent of seawater advance in the Kashan basin was to the northwest, in the Burdigalian. He also identified two sedimentary cycles with an advance from the south. Berberian (1983) considers the birth of the sedimentary basin of Qom formation. Deposition of the Qom Formation (with Rupelian–Burdigalian range) took place in three NW–SE-trending basins: Sanandaj–Sirjan (fore-arc basin), Urumieh–Dokhtar magmatic arc (intra-arc basin) and Central Iran (back-arc basin).

The deposits of the Qom Formation and the Alkaline volcanic processes have been accompanied by Aghanabati, 2004 and Nogol-Sadat, 1985.

The Oligocene-Miocene rocks of the studied area include: sandy marl unit and green sandstone, thin layers of limestone to thick red marls (Aquitanian-Burdigalian), cream-gray marl unit, alternation of gray sandstone and red-gray shale. It is accompanied by interlayers of marl and conglomerate (Figure 2).

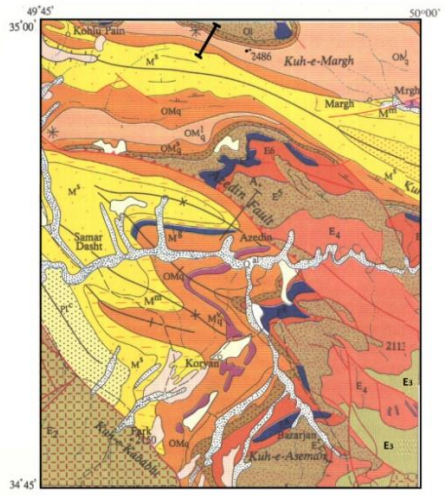

Figure 1: The position of the studied area of Qom formation in the southwest of Saveh (north of Arak) in the geological map of Qom (Emami, 1991).

Methodology

Sampling, analysis of samples and interpretation of results are three basic parts in exploratory geochemistry. At least three parameters should be considered in sampling:

1- Determining the most appropriate sampling environment as a function of project goals.

2- Observing the technical points of sampling in order to take representative samples.

3- Optimum sampling network design.

100 to 200 grams of samples were taken from the sampling area and from each sample, then the details of the sampling location and the samples themselves were recorded in the description sheets. Chemical composition determination test by XRF method. The reference standard ASM E 1621_13 was carried out at a temperature of 25 degrees Celsius, humidity: 30%. The elements cannot be identified due to their insignificance and are less than the measuring range of the device. In order to measure L.O.I (lost weight), the sample was placed at ۹۰۰degrees Celsius for one hour.

Stratigraphy and mineralogy

Chemical stratigraphy is based on the identification of distinguishing features from geochemical datasets obtained from sedimentary rocks. The difference in Zr/TiO_2 values is valid. However, zoning based on differences in CaO likely reflects variation in the size of calcite present in the sandstone and may limit the correct scaling of the correlation framework.

However, changes in Zr/TiO_2 values generally indicate heavy mineral materials (Ratcliffe et al. 2012) and assuming that it can be proven by heavy mineral analysis, changes in the Zr/TiO_2 ratio indicate a change in the origin of the sediment. And the possibility that there is an extensive lateral subregional complication that could provide a solid correlative framework is strengthened.

For these reasons, it is critical that when applying chemical stratigraphic facies in correlation studies, the importance of elements and element ratios used to define stratigraphic correlation are well understood.

Mineralogical affinity of elements

By determining the affinity of mineral elements, it is possible to determine to some extent whether their abundance and distribution are affected by changes in origin, environmental movement, climate, or not. Pierce et al. (2005a) used major element analysis to determine element relationships from which mineralogical affinities were inferred.

The main clay minerals are Illite, Smectite, and Kaolinite, the abundance of these clay minerals can be used to confirm stratigraphic differences in the abundance of key chemical stratigraphic elements, and can provide evidence for environmental changes, provenance, and diagenesis. In addition, the silty claystones have abundant amounts of mica, with small amounts of kaolinite and Illite to Smectite. The main heavy minerals of the Upper Permian Carboniferous sequences are zircon, tourmaline, rutile, apatite and Cr-spinel, with minor amounts of anatase, garnet, pyroxene, epidote, monazite and chloritoid (Morton et al. 2005; Pearce et al. 2005b).

AL and Si are mainly associated with kaolinite and Illite, Ca and Mg with carbonate minerals, Fe with pyrite.

Large amounts of Ti, Cr, Zr elements that result from geochemical effects can be used as a suitable marker for correlation. The mentioned geochemical changes not only strengthen the existence of changes in the origin obtained from heavy mineral and petrographic data, but also strengthen the correlation of chemical stratigraphy based on silty clay rocks.

Chemofacies

According to the results obtained from Qom, there are 9 chemical facies in the formation of the study area, and the ratio of elements is as follows (Fig, 3).

Chemical facies number 1

Ti/Al x 100 Titanium/Aluminum The ratio of titanium elements to aluminum x 100 is between 1-9 and 3-7.

In facies number 8, the lowest value is 0.45, and in facies number 9, the highest value is 7.11.

In facies 9-4-3-2-1, it is almost constant, but in facies 8-7-6-5, a strong fluctuation can be seen.

Chemical facies number 2

Cr/Al x 100 Chromium/Aluminum The value of the ratio of chromium elements to aluminum x 100 in 1-9 is between 0.22-0.05. In face No. 9, the lowest value is 0.0909 and in faces No. 5-7, the highest value is 0.2222. which is almost constant in facies 1-9-4, but a strong fluctuation is seen in facies -8-7-6-5-3-2.

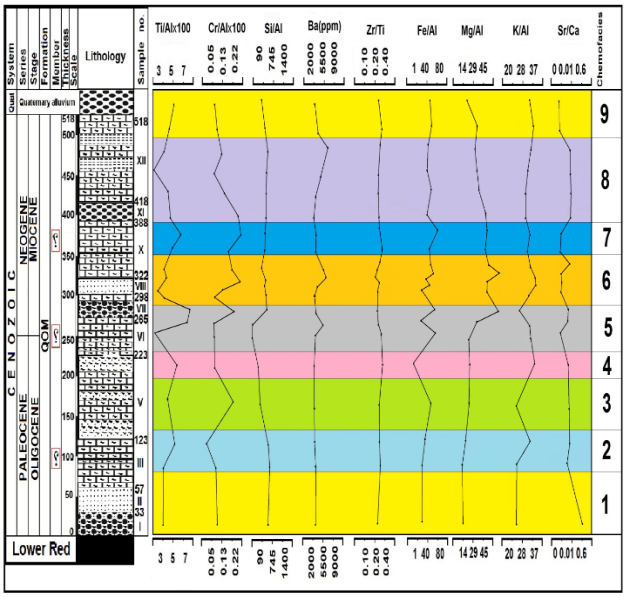

Figure 3. Chemofacies of Qom formation in the study area.

Chemical facies number 3

Si/Al Aluminum Silicon / The ratio of silicon elements to aluminum in 9-1 surface is between 90-1400.

In facies number 5-9, the lowest value is 95.3, and in facies number 5, the highest value is 1311.

It is almost constant in facies 1-9-8-7-6-4-3-2-1, but it fluctuates strongly in facies 5-6. will be

Chemical facies number 4

Ba (ppm) Barium The ratio of barium element in 1-9 facies is between 2000-9000 ppm.

In face number 7-4-2-1, the lowest value is 2240 and in face number 6, the highest value is 8960. which is almost constant in facies 1-9-7-4-3-2-1, but in facies 5-8-6 a strong fluctuation is seen.

Chemical facies number 5

Zr/Ti Zirconium/Titanium The value of the ratio of zirconium to titanium elements in 9-1 face is between 0.40-0.10. In facies number 6, the lowest value is 0.19 and in facies number 9, the highest value is 0.36. In facies 1-8-5-4-3-2-1, it is almost constant, but in facies 6-7-9, strong fluctuation is seen.

Chemical facies number 6

Fe/Al Iron/Aluminum The ratio of iron elements to aluminum in 1-9 is between 1-80. In facies number 4, the lowest value is 1.50, and in facies numbers 5-7, the highest value is 77.8. In facies 1-9-8-3-2-1, it is almost constant, but in facies 4-5-6-7, a strong fluctuation is seen.

Chemical facies number 7

Mg/Al Aluminum Magnesium/ The ratio of manganese elements to aluminum in the 1-9 surface is between 14-45. In face number 1, the lowest value is 14.69 and in faces number 5-6, the highest value is 46.67. which is almost constant in facies 1-8-7-4-3-2-1, but in facies 5-6, strong fluctuation is seen.

Chemical face number 8

K/Al Aluminum Potassium/ The ratio of potassium elements to aluminum in 9-1 surface is between 20-37. In facies number 7, the lowest value is 21.3, and in facies number 9, the highest value is 37.3. In facies 1-8, it is almost constant, but in facies 2-9-7-6-5-4-3-2, strong fluctuation is seen.

Chemical facies number 9

Sr / Ca Strontium/Calcium The ratio of elements of strontium to calcium in facies 1-9 is between 0.6-0.0. In facies number 0, the lowest value is 0, and in facies number 1, the highest value is 0.6. It is almost constant in facies 2-9-8-4-3-2, but in facies 1-5-6-7, a strong fluctuation can be seen.

According to the tests done and the obtained results, the lowest fluctuation of elements in facies 1-9 and moderate fluctuation of elements in facies 2-8-4 and extreme fluctuation of elements in facies 5-6-7.

In the chemical facies No. 5 is observed in the region of extreme fluctuation. Some elements in 9 faces have higher values than other elements, which are considered as dominant elements. Considering the dominant elements, it is possible to identify the mineral type of each facies**.**

Mineralogy

Mineralogy of chemical facies No. 1

Higher ratio of K/Al, Fe/Al, Ti/Al x 100 due to the presence of dominant mineral elements in facies No. 1, mica clay mineral, heavy rutile mineral, presence of oxyhydroxides such as hematite and Geotite and Ferron dolomite cements are found in sandstones.

Mineralogy of chemical facies No. 2

In this chemofacies, higher ratios of K/Al, Fe/Al, Mg/Al, Ti/Al x 100 due to the presence of the dominant mineral elements in facies No. 2, Russian basalt minerals, potassium daroo, titanium and carbonates, mainly siderite, calcite and dolomite which are affected by iron and hydroxides such as hematite, geotite, cement and dolomite in sandstones. The presence of heavy minerals, mainly rutile, and opaque minerals such as ilmenite and leucogene are also present.

Mineralogy of chemical facies No. 3

Higher ratio of Fe/Al, K/Al, Mg/Al due to the presence of dominant mineral elements in facies No. 3, Russian Basalt, Potassium Darocarbonate minerals, mainly siderite, calcite and dolomite, which are affected by iron and Hydroxides such as hematite, geotite, cement and dolomite are found in sandstones.

Mineralogy of chemical facies No. 4

In this chemofacies, higher ratio of K/Al, Mg/Al, Ti/Al x 100 due to the presence of dominant mineral elements in facies No. 4, Russian basalt, potassium dorocarbonate minerals, mainly siderite, calcite and dolomite, which are affected by iron and hydroxides such as hematite, geotite, cement and dolomite are found in sandstones. In this facies, hydroxys are more dominant.

Mineralogy of chemical facies No. 5

Higher ratio of Fe/Al, K/Al, Si/Al due to the presence of dominant mineral elements in facies No. 5, potassium basalt mineral, carbonate minerals mainly siderite, calcite, dolomite, heavy rutile mineral and Transparent like vulcogenous ilmenite.

Mineralogy of chemical facies No. 6

In this chemofacies, higher ratios of Fe/Al, Mg/Al, K/Al due to the presence of dominant mineral elements in facies No. 6, mainly carbonate minerals, siderite, calcite and dolomite along with micadarogranite clay mineral under the influence of oxides such as hematite, Geotite, cement and dolomite in sandstones with feldsparptasium-bearing butite mineral.

Mineralogy of chemical facies No. 7

In this chemofacies, higher ratio of Fe/Al, Mg/Al, Ti/Al x 100 due to the presence of dominant mineral elements in facies No. 7, carbonate minerals mainly siderite, calcite and dolomite along with heavy rutile mineral under tapir hydroxides Because hematite, geotite and dolomite are in sandstones.

Mineralogy of chemical facies number 8

higher ratio of Fe/Al, Mg/Al, K/Al due to the presence of dominant mineral elements in facies number 8, hydroxide minerals such as hematite, geotite and dolomite in sandstones and carbonate minerals mainly siderite, calcite and dolomite And granite rocks with potassium basalt.

Mineralogy of chemical facies No. 9

higher ratios of Fe/Al, K/Al, Mg/Al due to the presence of dominant mineral elements in facies No. 9, mainly carbonate granite rocks with siderite, calcite and dolomite along with potassium basalt. Hydroxide minerals such as hematite, geotite and dolomite are found in sandstones.

Conclusion

The ratio of elements Fe_2O_3/MgO, K_2O/Na_2O and Al_2O3/SiO_2 was used as the most valuable separator. To separate calcareous sandstones,

calcareous shales, stones and even calcareous clays, minor elements such as Mn (ppm), Ba (ppm), Rb (ppm), Ga (ppm) and oxides such as CaO%, Fe_2O3% and Al_2O_3 can be used. %, used SiO2%. According to the diagram of pattern and area (Bhatia, 1983) and Mazdouran, the classification of detrital silicate rocks based on the ratio of SiO_2 / AL_2O_3 and the amount of iron oxide (Sprague et al, 2009), shows the changes of important chemical elements in the studied sequence.

Therefore according to the results obtained in the Qom Formation, the studied area has 9 chemical facies. The percentage of elements Cr/AL_2O_3 versus TiO_2 / Nb, the chemical investigation of the detrital unit of the Qom Formation in the study area shows that most of the sandstones are of sedimentary origin.

The rate of stone in the area of siliceous stone, argillaceous sandstone, siliceous clay rocks with a small amount of iron, siliceous clay rocks rich in iron with low dolomite content is.

Determining the mineralogy of sandstones and chemical separation of the detrital units of Qom Formation based on their chemical data, the studied area has 9 different facies with different mineralogy.

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