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# Felsic Volcanic Rocks used in the Ceramic Industry in ChahBashe Mining Region (East Isfahan)

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**ABSTRACT**

The ChahBashehVolcanic rocks are is located in the Central Iran, 115 km from E Isfahan and probably of Precambrianage.Felsic volcanic rocks are composed from two types of rocks: rhyolite and toffrhyolite and contains quartz, plagioclase with high Albit, K-feldspar and Opaque. This Volcanic rocks has a FelsiticPorphyry texture with $SiO_2$ and K-feldspar. The Diorite dykes are the youngest magmatic products at ChahBasheh. Petrological, mineralogical study and geochemical investigations suggest that the Cha Bashehrhyolite is similar to those of the high-kcalc-alkaline series and metaluminous.high amount of $K_2O$ and its abundance in extrusive rocks and in the structure of minerals $K_2O$ is increasing surface tension, this region is economic. This research show that with adding artificial $Na_2O$ to composition of this rock,there can use in the ceramic industry.



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## INTRODUCTION

Central Iran zone is largest and most complication geological unit and it cover some parts of east Iran (north of Lut block).In this zone Precambrian rocks outcrops only in the eastern parts and includes gneisses, amphibolites, different schist, marble, mygmatite and granite anatexy. Geologically, Naein area located in central Iran zone [3,4,9,10].The study area is located in 115 kilometers east of Isfahan and 20 km south of Naein and that geographic location is between 53°15 - 53°30 and 32°15 - 32°35 (Fig. 1). In the area south of Nain some outcrops withInfracamprian age exsist.

Oldest rocks of the region belong to Soltanieh formation which includes dolomite - rhyolite - shale - limestone with some chert layers. This formation is distinct from other region formations by the fault along Naein - Baft (Dehshir - Baft) [4]. Limestone and shale formation are related to the lower Cambrian period containing fossils (Trilobites and Konodont) [15]. Outcrops of Infracambrianare reported as the dome and dyke in the south-east of ChahBasheh mine in east of Isfahan. Lithology combination is rhyolitewithporphyric texture. Parts of this unit are as tuff (Fig. 1).

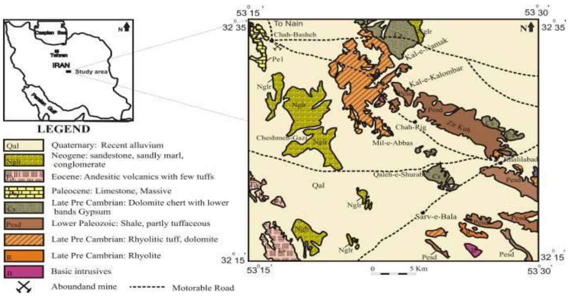


**Fig. 1:** Geological map of the area (1).

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*Research Methodology :*

During the field geology was colected of 60 rock samples from various parts of the study area. After studying the manual sample, 50 thin section preparation and was studied with polarizing microscope. Five samples with XRF method in centrallabIsfahan university (Iran ) andsevensamples withICP-MS method in ACMELabs Canada was the chemical analysis (Tables 1, 2, 3). Also, different softwares especially Excel, Minpet and Igpet were used for analysis and drawing charts.

*Results:*

Petrographically,felsic rocks are ranged rhyolite and composite quartzphenocrystals, albite plagioclase and alkali feldspar.The quartz can be seen in the field as phenocrystal and also microcrystal, quartz crystals are often subhedraltoeuhedraland and they are main rock forming minerals.Large quantities of quartz as large phenocryst with Gulf corrosion can be seen in these rocks. There are around quartz phenocryst,fine quartz and less alkali feldspar crystals. This margin can be caused by a fast rise and sudden decrease pressure on the rhyolite magma [13].

**Table 1:** chemical analysis data of the mager oxides with XRF method.

| Sample | Unit | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|
| Rock Type | | Rhyolite | Rhyolite | Rhyolite | Rhyolite | Rhyolite |
| $SiO_2$ | % | 69.71 | 74.32 | 75.23 | 76.86 | 75 |
| $Al_2O_3$ | % | 12 | 11.9 | 11.7 | 10.9 | 11.1 |
| $Fe_2O_3T$ | % | 0.98 | 2 | 1.23 | 1.13 | 1.32 |
| FeO | % | 0.38 | 0.75 | 0.47 | 0.42 | 0.45 |
| $Fe_2O_3$ | % | 0.56 | 1.16 | 0.71 | 0.66 | 0.83 |
| CaO | % | 4.34 | 0.71 | 1.59 | 0.38 | 0.62 |
| MgO | % | 0.28 | 0.19 | 0.17 | 0.09 | 0.18 |
| $Na_2O$ | % | 0.18 | 0.64 | 0.16 | 0.21 | 0.16 |
| $K_2O$ | % | 9.09 | 8.44 | 8.63 | 8.6 | 8.5 |
| $Cr_2O_3$ | % | 0.025 | 0.048 | 0.026 | 0.030 | 0.028 |
| $TiO_2$ | % | 0.15 | 0.12 | 0.14 | 0.13 | 0.14 |
| MnO | % | 0.046 | - | 0.045 | 0.04 | 0.041 |
| SrO | % | 0.005 | 0.008 | 0.007 | - | 0.006 |
| BaO | % | 0.072 | 0.066 | 0.059 | 0.067 | 0.065 |
| LOI | % | 2.94 | 0.95 | 0.81 | 1.33 | 1.4 |
| Total | % | 99.93 | 99.97 | 99.98 | 99.93 | 99.84 |
| Mg ≠ | | 36.14 | 15.96 | 21.60 | 13.70 | 21.53 |
| ACNK | | 0.53 | 0.82 | 0.74 | 0.83 | 0.83 |
| FM | | 0.67 | 0.86 | 0.81 | 0.88 | 0.80 |
| MALI | | 4.93 | 8.38 | 7.2 | 8.43 | 8.04 |
| $K_2O/Na_2O$ | | 50.71 | 13.19 | 53.94 | 40.95 | 53.13 |
| Б | | 3.22 | 2.63 | 2.39 | 2.2 | 2.34 |

**Table 2:** chemical analysis data of the main oxides with ICP-MS method.

| Sample | Unite | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rock Type | | Diorite | Diorite | Rhyolite | Diorite | Rhyolite | Rhyolite | Rhyolite | Rhyolite | Rhyolite | Rhyolite |
| $SiO_2$ | % | 52.94 | 49.42 | 75.39 | 54.56 | 73.65 | 75 | 69.14 | 74.88 | 74.56 | 69.23 |
| $Al_2O_3$ | % | 15.78 | 15.35 | 9.58 | 15.48 | 10.49 | 8.09 | 11 | 8.98 | 8.96 | 13.34 |
| $Fe_2O_3T$ | % | 11.84 | 12.44 | 5.08 | 11.02 | 1.02 | 1.22 | 2.89 | 1.39 | 1.17 | 3.79 |
| FeO | % | 6.56 | 7.06 | 2.16 | 6.03 | 0.38 | 0.51 | 1.3 | 0.56 | 0.47 | 1.46 |
| $Fe_2O_3$ | % | 4.55 | 4.60 | 2.67 | 4.32 | 0.59 | 0.65 | 1.44 | 0.77 | 0.65 | 2.16 |
| CaO | % | 4.58 | 7.14 | 0.08 | 4.51 | 3.02 | 1.55 | 1.06 | 1.16 | 0.27 | 0.7 |
| MgO | % | 4.19 | 4.68 | 1.48 | 3.81 | 0.15 | 0.08 | 0.15 | 0.083 | 0.05 | 0.2 |
| $Na_2O$ | % | 4.43 | 3.83 | 0.39 | 4.38 | 0.18 | 0.11 | 0.15 | 0.14 | 0.2 | 0.27 |
| $K_2O$ | % | 2.2 | 2.49 | 5.97 | 2.46 | 8.96 | 6.66 | 6.2 | 7.49 | 7.52 | 9.26 |
| $Cr_2O_3$ | % | 0.007 | 0.002 | 0.02 | 0.003 | 0.01 | 0.02 | 0.01 | 0.03 | 0.02 | 0.03 |
| $TiO_2$ | % | 2.72 | 3.16 | 0.072 | 1.99 | 0.13 | 0.11 | 0.43 | 0.12 | 0.11 | 0.23 |
| MnO | % | 0.096 | 0.16 | 0.015 | 0.075 | 0.044 | 0.02 | 0.25 | 0.04 | 0.035 | 0.03 |
| P2O5 | % | 0.77 | 1.03 | 0.006 | 0.96 | 0.025 | 0.041 | 0.19 | 0.023 | 0.034 | 0.16 |
| SrO | % | 0.04 | 0.07 | 0.002 | 0.04 | 0.004 | 0.01 | 0.03 | 0.01 | 0.004 | 0.01 |
| BaO | % | 0.08 | 0.06 | 0.03 | 0.06 | 0.07 | 0.06 | 0.008 | 0.06 | 0.07 | 0.05 |
| LOI | % | 1.29 | 0.18 | 1.98 | 0.68 | .1.24 | 6.72 | 6.98 | 5.69 | 6.94 | 4.62 |
| Total | % | 100.83 | 99.86 | 100.04 | 99.92 | 98.91 | 99.61 | 98.43 | 100 | 99.84 | 101 |
| Mg ≠ | | 41.45 | 42.89 | 36.75 | 40.87 | 22.71 | 12 | 9.36 | 10.67 | 7.82 | 9.5 |
| Eu/ Eu* | | 0.02 | 0.01 | 0.03 | 0.01 | 0.03 | 0.03 | 0 | 0.02 | 0.02 | 0.03 |
| (La/ Yb)N | | 19.18 | 16.47 | 7 | 25.65 | 6.64 | 8.79 | 55.79 | 8.78 | 18.63 | 4.39 |
| (Gd/ Yb)N | | 4.31 | 4.38 | 0.89 | 5.53 | 1.2 | 1.15 | 7.09 | 1.24 | 1.79 | 1.06 |
| ACNK | | 0.71 | 0.56 | 1.04 | 0.69 | 0.54 | 0.63 | 0.98 | 0.68 | 0.79 | 0.9 |
| (Nb/Zr)N | | 2.13 | 2.36 | 0.82 | 2.86 | 0.88 | 0.77 | 4.11 | 0.81 | 0.83 | 0.56 |
| FM | | 0.62 | 0.61 | 0.67 | 0.63 | 0.8 | 0.9 | 0.92 | 0.91 | 0.93 | 0.92 |
| MALI | | 2.06 | -0.81 | 6.28 | 2.34 | 6.12 | 5.22 | 5.29 | 6.47 | 7.46 | 8.84 |
| K2O/Na2O | | 0.5 | 0.65 | 15.45 | 0.56 | 49.99 | 58.84 | 41.33 | 52.44 | 36.69 | 33.69 |
| 6 | | 4.43 | 6.23 | 1.25 | 4.05 | 2.73 | 1.43 | 1.54 | 1.83 | 1.89 | 3.47 |

After quartz, plagioclase is the most frequent phenocryst. Plagioclases often have euhedralphenocryst, sodice composition and albite to oligoclase compositions. Most plagioclases are polysentetictwin. In these rocks two generations of plagioclase can be seen.

The first generation have large phenocryst of plagioclase which formed in the deep and the second generation of plagioclase microlites that occurred near the surface are signs that magma is cooling fastand have polysentetictwin [13]. Most plagioclases have been alterated to secondary minerals. Most of them are serisity and some of them is empty and are filled by minerals such as chlorite, penin(Mg, Fe, Al) $_{12}$ (Si, Al) $_8O_{20}$ (OH) $_{16}$ and calcite. Alkaline feldspar finds as fine crystal and is present as phenocryst that its value is low and often is kaolinite.

The minerals opaque can be mentioned as most important minerals in the microscopysections. The secondary minerals in these sections include serisit, chlorite (more Penin type), epidote and calcite.

**Table 3:** chemical analysis data of elements with ICP-MS method.

| Sample | Unite | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Diorite | Diorite | Rhyolite | Diorite | Rhyolite | Rhyolite | Rhyolite | Rhyolite | Rhyolite | Rhyolite |
| Ag | ppm | 52 | 27 | 57 | 45 | 128 | 58 | 46 | 223 | 46 | 68 |
| As | ppm | 7.8 | 6.7 | 2.1 | 22.7 | 16.4 | 6.2 | 3.3 | 4 | 24.7 | 3.6 |
| Au | ppm | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Ba | ppm | 724 | 561 | 285 | 519 | 627 | 540 | 74 | 489 | 608 | 415 |
| Be | ppm | 2 | 2 | 1 | 2 | 1 | <1 | 2 | 1 | <1 | <1 |
| Bi | ppm | 0.04 | <0.04 | <0.04 | 0.06 | <0.04 | 0.04 | 0.07 | <0.04 | <0.04 | 0.11 |
| Cd | ppm | 0.21 | 0.26 | 0.05 | 0.28 | 0.22 | 0.08 | 0.04 | 0.09 | 0.05 | 0.15 |
| Ce | ppm | 107.8 | 133.8 | 42 | 145.4 | 49.91 | 44.43 | 386.9 | 49.83 | 94.5 | 46.6 |
| Co | ppm | 41.4 | 49.3 | 0.8 | 30.7 | 1.5 | 3.7 | 6.3 | 2.5 | 1.2 | 1.3 |
| Cr | ppm | 49 | 11 | 136 | 20 | 76 | 170 | 87 | 213 | 137 | 194 |
| Cs | ppm | 0.6 | 1.4 | 0.7 | 0.9 | 1 | 0.6 | <0.1 | 0.8 | 0.6 | 0.8 |
| Cu | ppm | 31.08 | 42.8 | 4.12 | 29.79 | 9.49 | 7.86 | 7.32 | 10.49 | 15.2 | 9.46 |
| Dy | ppm | 7 | 9.5 | 1.9 | 7.8 | 2.7 | 1.6 | 7.1 | 1.9 | 2.1 | 4.2 |
| Er | ppm | 2.2 | 3.3 | 1.3 | 2.6 | 1.9 | 1.2 | 2 | 1.5 | 1.3 | 3.1 |
| Eu | ppm | 3.1 | 4 | 0.3 | 3.7 | 0.6 | 0.4 | 2.2 | 0.4 | 0.7 | 1.1 |
| Ga | ppm | 23.52 | 25.61 | 16.59 | 25.99 | 17.45 | 8.83 | 19.58 | 9.71 | 6.85 | 19.7 |
| Gd | ppm | 9.2 | 13.2 | 2 | 11.8 | 3.3 | 2.3 | 16.9 | 2.8 | 3.6 | 4.4 |
| Hf | ppm | 5.19 | 7.3 | 3.93 | 5.23 | 4.44 | 4 | 0.86 | 4.07 | 4.43 | 5.92 |
| Ho | ppm | 1.1 | 1.5 | 0.4 | 1.3 | 0.6 | 0.4 | 0.9 | 0.4 | 0.4 | 1 |
| La | ppm | 48.9 | 59.3 | 18.9 | 65.4 | 21.9 | 21.1 | 159 | 23.7 | 44.7 | 21.7 |
| Li | ppm | 20.5 | 25.2 | 23.1 | 21.1 | 3.4 | 3.3 | 5.4 | 2 | 2.8 | 1.9 |
| Rb | ppm | 46.5 | 54.9 | 102.4 | 44.9 | 187.5 | 109.1 | 100 | 123.2 | 140 | 202 |
| Sr | ppm | 351 | 547 | 17 | 336 | 37 | 49 | 246 | 44 | 37 | 57 |
| Y | ppm | 27.8 | 39.4 | 10.3 | 34 | 16.4 | 9.7 | 19.3 | 12.1 | 11.2 | 26.6 |
| Zr | ppm | 238 | 301 | 109.7 | 235.7 | 140 | 126.6 | 29.7 | 134.1 | 139 | 213 |
| Nb | ppm | 34.34 | 48.19 | 6.11 | 45.67 | 8.39 | 6.62 | 8.28 | 7.34 | 7.8 | 8.01 |
| Th | ppm | 5.1 | 6.4 | 13.4 | 6.7 | 8.8 | 8.4 | 11.6 | 10 | 12 | 8.1 |
| Pb | ppm | 24.42 | 20.35 | 2.47 | 26.69 | 31.56 | 2.5 | 1.81 | 4.59 | 4.73 | 19.9 |
| Zn | ppm | 190.1 | 239.5 | 25.1 | 97.9 | 15.3 | 4.8 | 5.4 | 9.9 | 7.6 | 21.3 |
| Ni | ppm | 51.2 | 44.8 | 6.2 | 10.9 | 7.2 | 13.3 | 20.9 | 15.9 | 11.1 | 9.1 |
| V | ppm | 159 | 154 | 5 | 93 | 7 | 6 | 64 | 7 | 7 | 18 |
| Ta | ppm | 1.9 | 2.4 | 0.4 | 2.2 | 0.4 | 0.3 | 0.5 | 0.4 | 0.4 | 0.4 |
| U | ppm | 1 | 1.3 | 2.3 | 1.3 | 1.9 | 1.9 | 1.6 | 1.9 | 2.1 | 2.3 |
| W | ppm | 113.7 | 3.7 | 73.3 | 6.3 | 37.2 | 37.3 | >200 | 59.6 | 38.4 | >200 |
| Sn | ppm | 2.8 | 3.3 | 0.9 | 1.9 | 3.5 | 1.2 | 1.1 | 1.4 | 0.9 | 1.9 |
| Mo | ppm | 2.47 | 2.09 | 1.33 | 2.42 | 1.95 | 2.86 | 4.28 | 3.65 | 2.44 | 2.45 |
| Pr | ppm | 12.8 | 16.6 | 4.8 | 17.8 | 6.2 | 5.2 | 40.9 | 5.8 | 10.6 | 5.6 |
| Nd | ppm | 55.9 | 71.2 | 18 | 72.4 | 24.5 | 19.4 | 165 | 23.2 | 41 | 25 |
| Sc | ppm | 10.9 | 12.4 | 9.3 | 7.7 | 7.8 | 6.1 | 20.9 | 6.5 | 4.6 | 9.5 |
| Sm | ppm | 10.5 | 13.4 | 3.1 | 13.2 | 4.2 | 3.5 | 26.8 | 4.1 | 6.8 | 4.5 |

These rocks have diversity in texture but the porphyric texture is the main texture in this rocks and particular texture are felsophyric and glomeroporphyric.

The main minerals that exist in the tuff are plagioclase and quartz that plagioclase is often albite type. The most important secondary minerals include epidote, calcite and opaque minerals. Calcite veins cutmicroscopy sections. Field is consists of a fine-grained ash tuff that it has been crystallized.

Average value of the main oxides in the samples is matching with general combining of rhyolite rocks. In these rocks $K_2O/Na_2O$ rate is more than one (13.19 to 58.84, 40.7average) and it indicate, rhyolite composition is potasic. ACNK molar ratio will change generally around 0.5 to 1 and indicate metaalumyniom. Mg # is with average value of 19.9 (7.8 – 39).

One of geochemical classification diagrams for volcanic rocks is oxide – oxide [2] (Fig. 2A), [6] classification volcanic rocks based on $Na_2O$ + $K_2O$-$SiO_2$ that were known as the TAS diagram. In this charts, samples placed in the rhyolite range. [7] were proposed total alkali vs. silica diagrams for separation alkali rock series from sub alkaline (Fig. 2B).Samples of region are showing semi-alkaline or sub alkaline afiliatly. Diagram of AFM (5) was used to determine the process of igneous series and for separation calc-alkalin magmas fromtholeiitiqueSamples show calc-alkalin properties (Fig. 2C).

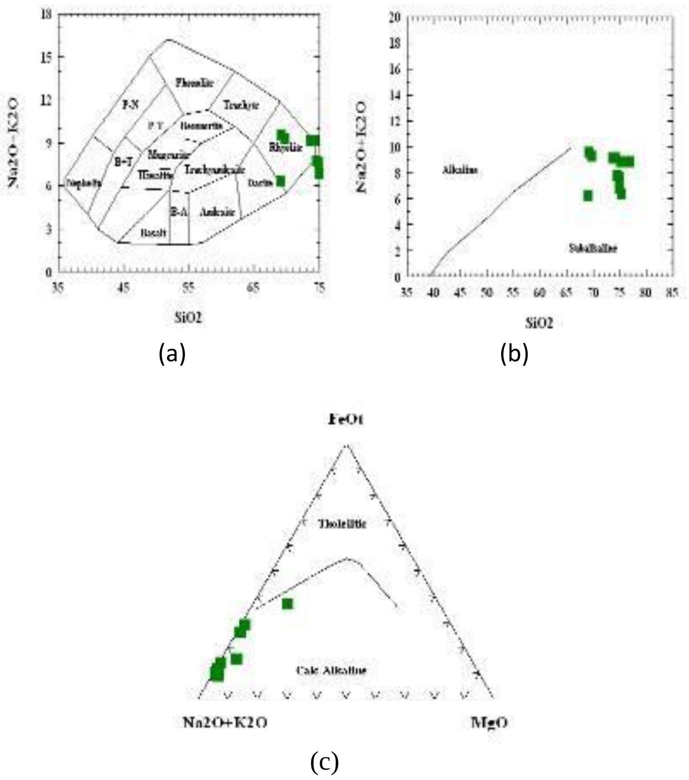



**Fig. 2:** A Cox and colleagues (1979) for volcanic rocks, B) the alkali vs. silica (7), for separation sub-alkaline and alkaline series, C) AFM diagramin which calc-alkaline series are separated from tholeiitique (5).

*Industrial properties:*

Rhyolite rocks are potasic series in An-Ab-Or (5) (Fig. 3A). The determination of potassium by Middlemost [8],Lemaître *et al* [7], Rickwood [12] provided that rhyolite samples (Fig. 3 B and C) are located in the range of high-potassium rocks to ultra potassic.

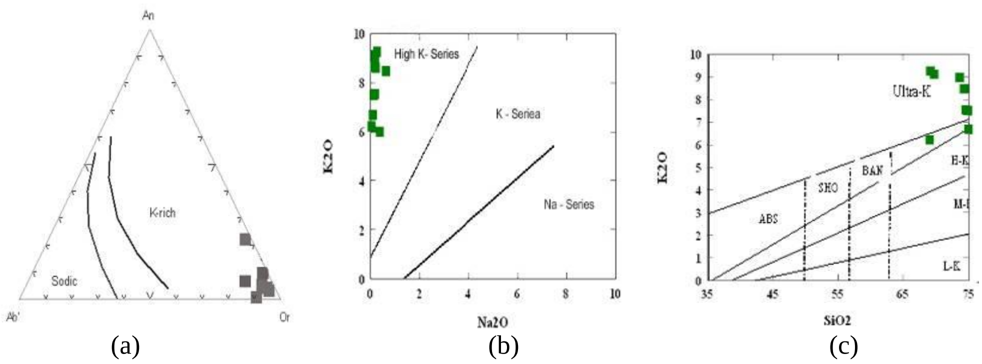



**Fig. 3:** A) the An-Ab-Or (5), B and C) the determination of potassium (8).

Highgrades of potassium increase the economic potential of the studied area. Feldspar is used in industries such as ceramic tile, glass, rubber making, industrial of production electrodes and sometimes as abrasives. If the amount of sodium and potassium in feldspar are more, feldspar is better and ismore applications. Other feldspar uses are:soap produce, cleaning material, powder filling and glass preparation, preparation of abrasives and

dental costs and more. In terms of trade,microcline, pertite, albiteand Oligoclasefeldspars have economic value. Alkali feldsparshave many industrial applications but plagioclases havenot. In any case,cannot be exploiting from all the feldspars because deposit making in some types of them are very limited and contains annoying minerals. Substantial economic,major source of exploitation feldsparsis limited to coarseacid igneous rocks. Ofapplication, ratiobasic oxides than aluminum and silica oxides play important role that this ratio in the alkali feldspars isrespectively 1:6:6 and in soil of alkali feldsparsis 1:2:2. Overall, consumption of feldspar in the industrialized world is as follows:
- 65% in glass-making industries
- 30% in ceramics and porcelain industries
- 5% in other industries

Always necessary to notice that factories need to high purity feldspars. So in areas where reserves of feldspar arenot ready to use perforce doextractionand mineral processing offeldspar. Since mineral processing is the most basic factors for prepare feldsparin industries, so had a direct impact in quality and quantity of final product and it has severely affected in added value.Feldspar powder is used as a melting aid in ceramic industry because this powder due to sodium and potassium, relatively melt in low temperature in the ceramic and covers other materials as a glass. In this sense, it is the main raw material in preparing porcelain, tiles, quality clay, variety ceramic, building insulator and toiletries.

One of the important uses of feldspar is in the production of porcelain and ceramic. Generally, the primary rocks that are used for produced feldspar in ceramic industry should be as follows (Table 4).

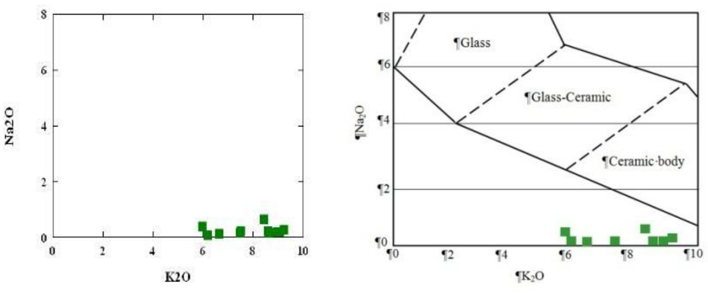
**Table 4:** Specification of primary rock for produced feldspar in ceramic industry.

| Profile | medium rock | good rock | very good rock |
|---|---|---|---|
| Amount offeldspar | 15-50 | 50-65 | 65 |
| $Na_2O/K_2O$ | 1-3 | 3-5 | 5 |
| % $Fe_2O_3$+$TiO_2$ | 1-3 | 0.25 | 0.25 |
| %Amount ofclay minerals | 10 | 0.5-1 | 0.5 |
| freedom degrees of Ironores (mm) | 0.15-0.25 | 0.25-0.5 | 0.5 |

Percentage of feldspar should be high in rock and at least about 50 percent. Also in ceramicindustry$Na_2O/K_2O$ ratio must be higherthreeand it is used less in the glass industry. Percentage of iron oxide must be maximum one percent. In this region ratio $Na_2O/K_2O$ is higher three and percentage of iron oxide up to one percent.

Chemical composition of feldspar types will determine its industrial use. $Al_2O_3$ increasesheat and hogging resistances. $Na_2O$ reduces melting temperature and adherence.$K_2O$ increases surface tension.In diagram of$K_2O$ vs. $Na_2O$ K2O is swing between 6 to 9 percent (Fig. 4A). This chart can be concluded that South Naein feldspars are rich in potassium.

Study area feldspar types are drawn based on $Na_2O$ and $K_2O$ oxides (Fig. 4B) and three major areas of alkali feldsparsis seen in it. According to this diagram, the South Naein feldsparsare outside of ceramic (body) range and are due to the lack of $Na_2O$ in the study area rocks.




(a) (b)

**Fig. 4:** A) Diagram percentage $Na_2O$ vs.$K_2O$ of felsic masses in South Naein. B) The range of changes $K_2O$ and $Na_2O$ in feldspars that are used in ceramic and glass industries.

*Conclusion:*

Felsic volcanic rocks in the study area in terms of mineralogy and chemical composition are classified in rhyolite groups There are features at phenocrystessuch as the Gulf corrosion in quartz,·hay fringe and resorption quartz and plagioclase corrosion in all cases that indicate a chemical imbalance and rising magma and rapid reduction in pressure and raised to the role of continental crust or magma mixing [11].Felsic rocks of sub-alkaline geochemical nature are calc-alkaline. Studied rocks in terms of LREE and LILE elements shows many

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enriched. Wilson [16] believes rhyolitesubduction regions are sub-alkaline, high potassium (K> 4 wt%), being rich in iron (FeO / MgO> 3.1) and silica is the symptoms of subduction rocks.

In chemical composition of samples,the amount of $K_2O$ between 6 and 9 varies. The large amount of $K_2O$ and abundance of this masses in the area and insomuch $K_2O$ is increased surface tension in the structure of minerals,this region will be applied to economic zone, but using different feldspar charts, samples were out of range ceramic (body) and these are due to lack of $Na_2O$ in the study area rocks. Therefore, with synthetic addition of $Na_2O$to rocks can used from themin ceramic industries and these comments are economic.

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