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# Mineralogy, geochemistry, genesis, and industrial application of silica in Arefi area, south of Mashhad

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## Introduction

Arefi quartz-bearing conglomerate (Middle Jurassic) is situated within Binalud structural zone. The unit is trending NW-SE located 25 km south of Mashhad. More than 97% of the pebbles are quartz as mono-crystalline, poly-crystalline, and minor fragments of chert, quartzite, and mica schist. Less that 3% of the remaining minerals are feldspar, mica, chlorite, hornblende, tourmaline, zircon, sphene, and opaque minerals. The cement is mainly silica. Hashemi (Hashemi, 2004) suggested this unit is orthoquartzitic polymictic conglomerate.

In this study, we carried out detailed mineralogical studies, geochemical analyses for $SiO_2$ and troublesome elements, determination of quartz pebbles source using geological observations and fluid inclusion microthermometry, and industrial application studies with new insight for porcelain and ceramic factories as the nearest silica-rich reserve to Mashhad.

## Material and methods

1. Preparing geologic map in 1:10000 scale in the Arefi area.
2. Petrographic study of 65 samples from the quartz-bearing conglomerate unit.
3. Major elements such as $SiO_2$, TFeO, $TiO_2$, and CaO were analyzed at the Maghsoud Porcelain Factories Group, using a Philips PW1480 X-ray spectrometer.
4. Ore dressing analyses in Danesh Faravaran Engineering Company.
5. Fluid-inclusion studies in 4 samples doubly-polished wafers of quartz crystals were studied using standard techniques (Roedder, 1984) and Linkam THM 600 heating-freezing stage (from –190 to 600ºC) mounted on a Olympus TH4–200 microscope stage at Ferdowsi University of Mashhad, Iran. Salinities and density of fluid inclusions were calculated using the Microsoft Excel spreadsheet HOKIEFLINCS-$H_2O$-NACL (Steele-MacInnis et al., 2012; Lecumberri-Sanchez et al., 2012)

## Results and Discussion

Fluid Inclusion studies of both mono- and poly-crystalline quartz revealed that the inclusions consist of three phases (LVS) with NaCl crystals. Homogenization temperature is between 484 and more than 600ºC with average 559ºC and the salinity is between 49.6 and 72.1 wt% NaCl with average 61.2 wt% NaCl. These data indicate a magmatic origin according to Kesler (Kesler, 2005) diagram. Homogenization temperature of two phases (LV) inclusions in the metamorphosed quartz is between 287 and 365ºC with average 318ºC. The main source of quartz pebbles is quartz veins formed within the top of pegmatite-granite (upper Triassic) of Khajeh-Morad area and quartz veins formed due to regional metamorphism.

Based on chemical analysis of 93 samples which were taken from the surface (channel method) and power drilling, the $SiO_2$ content is more than 98%, TFeO is less than 0.42% and $TiO_2$ is less than 0.16%. The proved ore reserve is more than 50 million tonnes. Using dry magnetic method, the TFeO became less that 0.03% and $TiO_2$ less than 0.02%. Arefi silica deposit is a first-class reserve and can be used in different types of ceramic.

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