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NOTE

Geochemical Properties of Fire Opal Occurences in Kütahya (SW Turkey)

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The Simav fire opal occurences have specific characteristics. It has a variety of appearance micro and nanostructures. Chemical, mineralogical properties, optical observation and SEM analyses of Simav fire opal occurences have been investigated. Micromorphology, crystal structure, particle size were examined. To purpose scanning electron microscopes used on microtextures on fire opal. The yellow to brown colour is correlated with Fe concentration. The purpose of the peresent investigations are two fold (1) clarify the microtextures at a level of nanometer scale (2) to analyze the mechanism of their formation.

Key Words: Fire opal, Simav, SEM analyses.

Opal is an amorphous to poorly crystallized variety of silica. Dehydration experiments show that most of the H_2O in the formula of $SiO_2 \cdot nH_2O$ of opals is present in the familiar form of clusters of molecular water. Fire opals are transparent to transculent solids with warm body colours yellow, orange, orange-yellow or red. They dont show any play of colour. Fire opal is transparent and characterized by an orange body colour, hence its name. This body colour originates from the light absorption by needle like iron(III) oxides nanoparticles and unstable under the electron beam of a transmission electron microscope.

Recent studies shown that coloured opals are coloured by micro-nano meter size inclusions, when the origin of colour could be established[1]. A purpose of the present study is to demonstrate that the structure of fire opal from Simav. The structure of opals seems to be different for the two mineralogical groups of opals, which are opal A and opal CT. These groups were defined on the basis of X-ray diffraction (XDR). They correspond to two different states of crystallinity: opal a is amorphous and opal CT is disordered cristobalite with tridymitic stacking[2].

Opal-A made of spheres generally cemented together with the little particles[3]. Previous works show that if opal occurs are not play of colour it is mostly because of their sphere are inhomogenous diameter.

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The present work is based on scanning electron microscopy (SEM). All samples were observed with the SEM, first on a fresh break, then after a 30 s attack (Standard attack to reveal opal microstrucure) with hydroflouric acid diluted to 10 % volume in water. They were coated by a film, about 5 nm thick, of gold-palladium alloy. The qualitative chemical analyses were performed on GEOL-600 scanning electron microscope (SEM)

It is the regularity of the sizes of spheres and of the packing of these spheres that determines the quality of precious opal. Simav fire opal at the microscale is composed of silica spheres some 150-300 nm in diameter.

The samples (Fig. 1) originate from Simav, Turkey. No organized structure is observed in SEM on a fresh break (Fig. 1). Rather, the surface appears slightly garnular. The material appears that it builts from elementary nanoparticles 10-30 nm scale. In addition, the seperation between grains ranges from distinct low contrast. It appears as a conglomerate of grains of several tens of nanometers as nanograins.

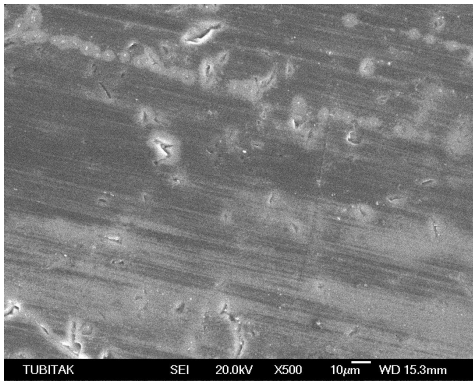

Fig. 1. Palygorskite on fire opals surface

From this images, it is clear that aggregation of small near-spherical grains is about 20 nm in size on average. The apparent diameter of these grains actually ranges from about 10-50 nm for the largest.

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The chemical analyses using SEM suggest that the major part of the material is actually SiO_2. (Fig. 2) Optical microscopy revealed the same basic texture for the fire opals: a matrix of isotropic opal with optically undeterminable phyllosilicates with high birefringence. After HF attack, granular structure is confirmed on all samples which look much alike (Fig. 1).

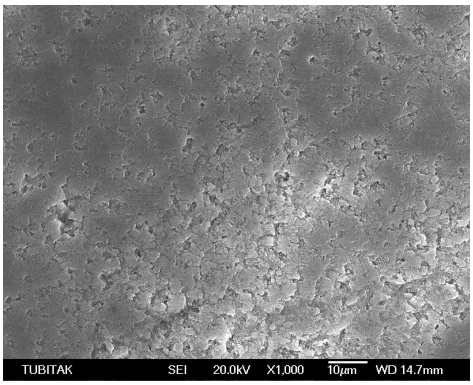

Fig. 2. Fire opal no organized structure can be seen with the SEM in Fig. 2 at 1000 magnification. The surface appears slightly granular. The opal material appears built from elementary nanoparticles 10 to 30 nm randomly

Simav fire opal microstructures are long fibres of 20-30 nm in minimum diameter. These form bundles of ten microns or more, these bundles being distributed in different orientations.

SEM investigations reveal that palygorskite fibers and and opal nanograins are intermixed at a small scale. It is about 20 nm. The SEM images for this reason fibrous texture is observed clearly. But it is difficult distinguish between them.

On the thin sections, chemical analyses made using SEM proved that the major part of the material is actually SiO_2 (Table-1).

TABLE-1
Si AND O ARE AS MAJOR ELEMENTS SEEN IN FIRE OPAL OCCURRENCES

Element	Weight (%)	Atomic (%)
O K	49.60	63.33
Si K	50.40	36.67
Total	100.00	

TABLE-2
Fe AND Al ELEMENTS SEEN IN FIRE OPAL

Element	Weight (%)	Atomic (%)
O K	46.74	60.81
Al K	0.71	0.55
Si K	51.75	38.35
Fe K	0.79	0.29
Total	100.00	

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