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Research Article

RARE ACCESSORY MINERAL SUESSITE - Fe_3Si FROM TIEN SHAN AND CONDITIONS OF ITS FORMATION

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ABSTRACT
In the ore-bearing rhyolites of the Chinarsay deposit we found rare accessory minerals: As we know, Suessite is the second discovery in the Earth and it's new species of manganese Wüstite. Based on data of previous authors and our new data we are suggesting the causes of Suessite formation on the Earth and three types of favorable geological environments.

Keywords: *Suessite, Accessory Mineral, Chemical Composition, Formation, Chinarsay Deposit*

INTRODUCTION
Suessite is very rare mineral. It is encountered in meteorites (Kelle *et al.,* 1980). For the first time in the Earth it is found in the Chatkal Range (Uzbekistan) in the amygdales of alkali basalt porphyry of P_1. Suessite-like mineral $(Cr, Fe)_3Si$ was found in Kurama Ridge in dykes of gabbro - diabase T_1 in Gavasay area (Novgorodova *et al.,* 1983).

Study Area
Chinarsay deposit is located in the south-western spurs of the Hissar ridge of Tien Shan (Ore Deposits of Uzbekistan, 2001). In the geological structure of the Chinarsay deposit are involved products of the activity of Chinarsay paleovolcano of the Lower Carboniferous period.

For the products of Chinarsay paleovolcano - lava flows and tuffs there are characteristic different facial and textural varieties: vesicular- spherolitic structure, spherical, fluidal, breccias like, perlite, pyroclastic and others. In rhyolite porphyry sometimes there are small secondary spherulites, formed in places of glass devitrification. There are observed spherolitic differences, combination of spherolitic and amygdaloidal texture, conditioned by vesicular lava in connection with the separation of fluidal and gas components. Spherolitic structures constitute in some areas up to 50-60% of the rock volume. Spherolitic structures size is from 1 mm to 5 cm in diameter. Their internal structure is composed of - quartz, sometimes with albite and needles of ore material. In the rhyolite porphyry tuffs, there are also transitional formations to the ignimbrites. In the ore-bearing rhyolites we found rare accessory minerals: Suessite, it is the second discovery in the world (Khabibullaeva *et al.,* 2013) and it's new manganese Wüstite species.

MATERIALS AND METHODS
Studying of Suessite was done by special mineralogical and geological conducts and analytic methods. Researches contain field geological and laboratory works. Field works consist of studying geological structure of the deposit, sampling, geological-mineralogical profiling.

Mineral features and chemical composition of Suessite were determined by polished and thin sections, using modern electron probe X-ray spectrum microanalysis (JXA -8800R "Superprobe"). Analyses were done at the laboratory of Institute of Geology and Geophysics Uzbek Academy of Sciences.

RESULTS AND DISCUSSION
Suessite was met in rhyolites as second discovery on the Earth while studying mineral composition of gold-pyrite-polymetallic ores of Chinarsay deposit. It has form of oval egg-shaped precipitates with dense structure up to 65x100 microns (Figure 1). All the known analyses, including our results of chemical composition of Suessite are presented in Table 1.

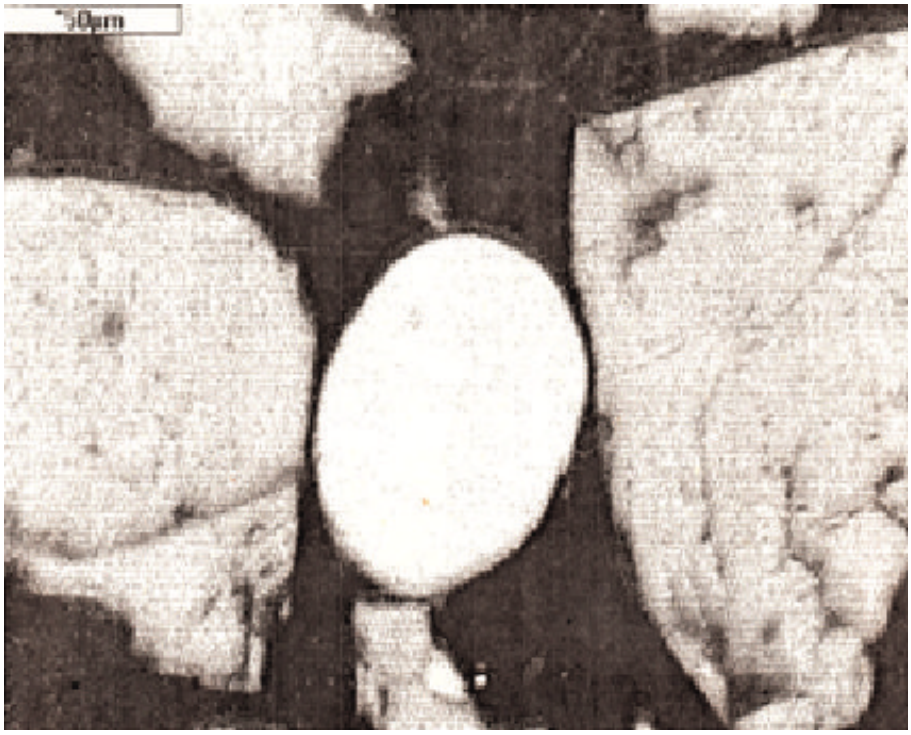

Figure 1: Oval Buildup of Suessite and Wüstite Crystals in Perlite of Rhyolite Tuff Lava

Table 1: Chemical Composition of Suessite and it Chrome Analogue

Element	Hissar Range, Chinarsay Deposit. Rhyolite C_1		Chatkal range, Porphyrite (P_1)		Basalt	Kurama Range, Gavasay. Gabbro - diabase	Meteorite (Inclusion)
Fe	85,47	87,77	82,64	87,56	86,59	21,8	81,7-87,0 (83,9)
Si	13,90	11,70	13,52	13,60	13,50	15,2	12,8-16,4 (14,6)
Mn	0,63	0,55					
Ti	-	-	0,002	0,17	-	7,1	-
V	-	-	0,23	0,29	0,29	-	-
Ni	-	-	0,09	0,09	0,09	0,2	0,4-6,4 (2,18)
Co	-	-	-	-	-	-	0,16-0,40 (0,33)
Cu	-	-	-	-	-	0,1	-
Cr	-	-	-	-	-	55,2	<0,02-0,25 (0,11)
P							<0,01-0,25 (0,19)
Total	100,0	100,02	100,10	101,70	100,48	100,3	
Authors	Our data		Novgorodova *et al.*, 1983				Kelle *et al.*, 1980

Note: number 1-5 and 7 - Suessite, number 6 - chrome analogue of Suessite. Crystal chemical formula of Suessite from Chinarsay: $(Fe_{3,05}\ Mn_{0,02})_{3,07}Si_{0,97}$ and $(Fe_{3,13}\ Mn_{0,02})_{3,15}Si_{0,84}$. Mineral under №6 probably is a variety of ferrian, yet unknown, new mineral Cr_3Si and the intermediate member of the proposed new isomorphous series Fe_3Si - $(Cr,Fe)_3Si$ - Cr_3Si

Causes of Suessite Formation on the Earth

In view of the representations of Novgorodova *et al.*, (1983) and our data, we are suggesting the causes of Suessite formation on the Earth and three types of favorable geological environments.

Type 1. In an extreme subvolcanic situation of the cooling lamproite magma of deep origin in the explosion vents and diatreme (Koshmansaydiatreme, Chatkal range). Suessite formation occurs due to the

impact of post-magmatic fluids enriched with gases (N_2, C_2H_4, CH_4, CO_2) on amygdaloidal basaltoids of potassium alkalinity. The deposition of spherical Suessite occurred in a reducing atmosphere in the amygdales and the pores in association with titanium carbide khamrabaevit, graphite, othersilicides.

Specific nature of diatreme rocks is in inclusions of thermal barophilic minerals - diamonds, native metals, silicide, carbides of Fe, Ti, Mn and others.

Type 2. In the extreme environment of submarine eruption of Chinarsay paleovolcano accompanied by outflow of acid lava, a rapid drop of high temperature and pressure. Oval buildups of Suessite are formed among semi-devitrified siliceous perlite rhyolites in association with Mn- wüstite (Mn-11,2%) and Fe carbide of spherical shape. Crystallization of Suessite occurred in a reducing atmosphere at the outflow of acidic lava in sea basin and refers to the initial stage of development of ore-magmatic system with gold-pyrite-polymetallic mineralization (Hissar Range).

Type 3. Mineral $(Cr_2Fe)_3Si$ of Suessite family forms in hypabyssal conditions in connection with the intrusion of the main magmatic melt in the Earth's crust in the form of dikes of gabbro-diabase (Gavasay, Kurama Ridge).

It fill-up the middle zone of ore balls with native chromium in the core and cohenite in the outer zone. It is believed that the formation of this association is connected with post magmatic processes of cooling magmatic melt.

Conclusion

1. Formation of Suessite is connected with high temperature magmatic processes (outflow of acid magma, lamproite diatreme).
2. In the process of development of ore-magmatic system of Chinarsay paleovolcano occurrence form of iron was changed: silicide-oxide (paragenesis of Suessite and Wüstite) → low-sulphide (pyrrhotite) → sulphide (sulfide ore -polymetallic) → hydrothermal sulfide (gold- chalcopyrite-pyrite).

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