All these topics seemingly unrelated to DWCA, taken together, might drop a hint at the origin of Fe- and Ti-enriched rocks of kosvite series.

The DWCA varieties localized in cratonic domains and mobile belts make up a genetically coherent series related to wehrlitic mantle sources as products of decarbonation of previously carbonated peridotites [7]. The geochemical difference between DWCA formed in cratons and mobile belts is determined by nature, depth of origin, and thus variable LILE and HFSE contents in carbonate material reacted with peridotite protolith and by so far poorly understood enrichment of sources and melts in Fe and Ti. All diversity of rocks pertaining to DWCA was formed in partially molten wehrlite diapirs that originated at a depth of no greater than_80 km probably by merging of veins and then extruded into the crust under loading of overlying rocks or/and tectonic compression.

The metallogenic specialization of DWCA in mobile belts and continental cratons is the same (Fe-Ti and Fe-Cr oxides and PGE intermetallic compounds). The pristine magmatic matter of DWCA is depleted in sulfur, chlorine, and water. Exotic economic sulfide deposits presumably related to DWCA, e.g., Pechenga, were fed by sulfur from external sources. Mobile belts are more appropriate than cratons for the formation of economic titanomagnetite deposits and PGM-bearing chromite mineralization as a source of PGM placers. The redistribution and local concentration of ore components and recrystallization of ore minerals in the course of superimposed thermal and hydrous metamorphism create favorable conditions for increasing scope of primary ore and for enlargement of PGM mineral grains to the size sufficient for their accumulation in placers.

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THE PETROGENETIC SIGNIFICANCE OF THE RARE SULFIDE DJERFISHERITE: AN EXAMPLE FROM THE GULI DUNITE MASSIF (POLAR SIBERIA)

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INTRODUCTION

After its discovery in a meteorite [1] the uncommon sulfide djerfisherite, ideally $K_6(Fe,Cu,Ni)_{25}S_{26}Cl$, has been reported from different terrestrial localities [2,3,4 and references therein]. The data available

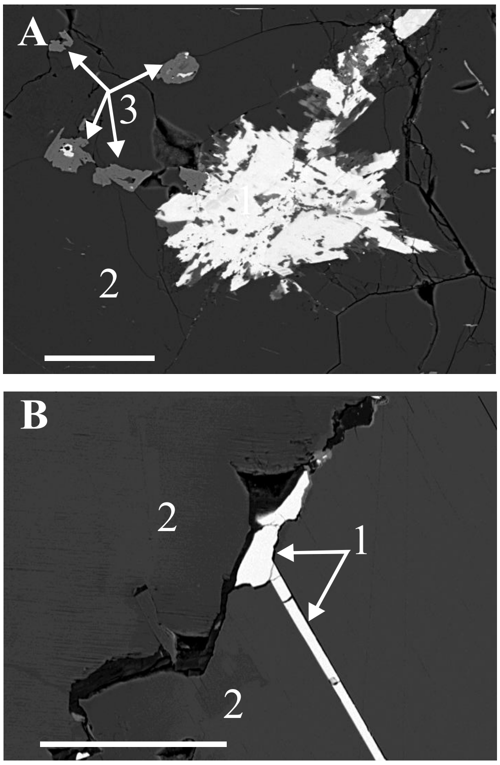

Fig. 1. Back scattered electronic (BSE images) of Guli djerfisherite.

A = irregular grain of djerifsherite (1) in contact with phlogopite (2) that includes small crystals of apatite (3). B = djerifsherite (1) in phlogopite (2) and along its cleavage plane.

Table 1

Reflectance values for djerfisherite from Guli massif

Wavelength	R% in air	R% in oil
400	15,8	7
420	17,1	7,9
440	18,4	8,8
460	19,6	9,6
470*	20,2	10,1
480	20,8	10,4
500	21,8	11,1
520	22,8	11,6
540	23,6	12,2
546*	23,8	12,3
560	24,2	12,6
580	24,9	13
589*	25,3	13,2
600	25,5	13,4
620	26	13,7
640	26,3	13,9
650*	26,2	14
660	26,7	14,1
680	27	14,3
700	27,1	14,5

**Wavelenght specified by the IMA. Commission on Ore Mineralogy (COM).*

in literature indicate that the composition of djerfisherite is strongly influenced by its host rocks, especially as it regards the substitution among Fe-Cu-Ni. As a consequence, djerfisherite can be con-sidered a good candidate to be used as a petrogenetic indicator. In this contribution, we reported chemical and physical data on djerfisherite found, for the first time, in the dunite occurring at Guli complex (Polar Siberia). The composition of djerfisherite is compared with chemical data from other terrestrial localities and meteorites. The results are used to better understand its genesis and to provide new insights into the origin of this uncommon mineral, associated with mantle-derived rocks.

GENERAL GEOLOGY OF THE GULI MASSIF AND SAMPLE DESCRIPTION

The Guli complex is located in the Taymir Province of northern Siberia, and is characterized by a considerable size and a complicated geology [5]. Including its part buried by quaternary sediments, the complex covers an area of about 2000 km^2, representing, therefore, the largest dunite-clinopyroxenite massif in the world. The exposed part is composed predominantly (about 60%) of variably serpentinized dunite. Melanocratic alkaline rocks cover about 30%, and other rock types, such as melilitolite, ijolite, alkaline syenite and carbonatite occupy less than 10% of the area [5 and reference therein]. Wehrlite and magnetite-rich clinopyroxenite form dykes, stockwork and lenticular bodies within the dunite. The Guli complex represents a composite multistage pluton and six principal intrusive stages have been recognized [5]. The Guli complex has been extensively drilled in the past and the investigated samples were obtained from a drill core (G.28, 506 meters long) located at the edge of the dunite core complex close to a carbonatite intrusion. They were collected by one of us (O.A.R.T.) in August 2003. The drill core (G.28) represents a single clinopyroxenite stock within the dunite and it consists predominantly of phlogopite and magnetite rich clinopyroxenites with abundant veins and dykes of carbonatite, up to 1.5 meters in thickness. The sample that contains dierfisherite is a coarsegrained phlogopite- and magnetite-rich clinopyroxenite with Ti-bearing andradite, a perovskite-group mineral, minor apatite, calcite, titanite, rare plagioclase, zircon, pyrophanite and disseminated patches of sulfides. Djerfisherite forms crystal up to 100 µm in size and occurs associated with these irregular patches of sulfide composed mainly of pyrrhotite with minor chalcopyrite and rare galena. It shows a variable shape: it forms irregular single crystals or it fills fissures of the silicate matrix and infiltrates phlogopite along its cleavage planes (Fig. 1). The textural relationships of djerfisherite and associated sulfides suggest that they crystallized simultaneously.

Table 2

Atomic parameters of djerfisherite from Guli Massif with standard deviations

atom	site	*x*	*y*	*z*	U_{eq}
S1	1*a*	0	0	0	0.026 (3)
S2	12*h*	0.24813 (44)	0,5	0	0.029 (1)
S3	6*f*	0,5	0,5	0.25909 (55)	0.025 (1)
S4	8*g*	0.22800 (29)	0.22800 (29)	0.22800 (29)	0.030 (1)
K	6*e*	0	0	0.29846 (50)	0.034 (1)
Cu	1*b*	0,5	0,5	0,5	0.045 (3)
Fe	24*m*	0.13537 (17)	0.36721 (13)	0.36721 (13)	0.030 (1)

Atomic parameters x, y, z. *U_{eq} = equivalent thermal factors. E.S.D. Refers to the last digit.*

PHYSICAL DATA AND CHEMICAL COMPOSITION OF THE GULI DJERFISHERITE

The microhardness values of the Guli djerfisherite vary from 132 to 154 (average of 30 measurements). The Raman spectra, obtained using a 632.81 nm excitation wavelength, display a clear peak at 300 cm^{-1}. In plane-polarized reflected light, djerfisherite is pale brown in color, with no internal reflections and no discernible anisotropism. Reflectance measurements are reported in table1. The crystal of djerfisherite of Guli has a cell edge equal to 10.385(5) Å, close to that reported by [6]. The refined atomic parameters are presented in table 2. The chemical composition of Guli djerfisherite, obtained using microprobe analyses, shows that the content of Fe is relatively constant (36.66 and 37.88 wt%) whereas the Cu amount is more variable (15.84 to 19.54 wt%). Nickel may reach 2.45 wt%, although in some grains, its content is below the detection limits. Potassium shows a narrow range of variation between 9.23 and 10.53 wt%. Chlorine varies from 1.07 to 1.45 wt%, contents of Na is negligible. Our data indicate that the Guli djerfiherite, calculated on the basis of 58 atoms approximates to: $K_{6.31}(Fe_{17.29}Cu_{7.49}Ni_{0.34})_{\Sigma 25.12}S_{25.52}Cl_{1.05}$. It is clear that the Guli djerfisherite deviates from the theoretical composition due to its enrichment in K and Fe,Cu,Ni and slight deficiency in S. The obtained data display that Cl is an important component in the analyzed djerfiherite whereas Na is below detection. Small compositional variations were found from grain to grain, whereas variations within a single crystal were not detected. Therefore, the analyzed grains can be considered compositionally homogeneous.

COMPARISON WITH DJERFISHERITE DATA IN LITERATURE AND CONCLUSIONS

Several kimberlites, alkaline ultramafic-mafic complexes and sulfide deposits worldwide contain djerfisherite. It rarely occurs in alkaline felsic rocks, in carbonatite and in metamorphic calcareous rocks [3 and reference therein]. According to [2], the substitution of Fe-Cu-Ni in djerfisherite is mainly controlled by the nature of its host rocks. Therefore, the composition of Guli djerfisherite is plotted in terms of Fe-Cu-Ni (at%) and compared with that from different locations and rock associations from the literature (Fig. 2). According to the ternary diagram presented in figure 2, the Guli djerfisherite is very similar to those found in alkaline rocks. Regarding the origin of djerfisherite, there is a general consensus that most occurrences of djerfisherite represent the product of metasomatic alteration of pre-existing alkali-free magmatic sulfides by introduction of K- and Cl-bearing fluids. However, the origin of these fluids, as well as the place where they formed, i.e. mantle versus crust, is still matter of discussion. In some cases, djerfisherite is considered to be a primary phases crystallized from evolved melts [4]. It can also represent the product of a fractional crystallization sequence, in a closed system, with estimated tem-

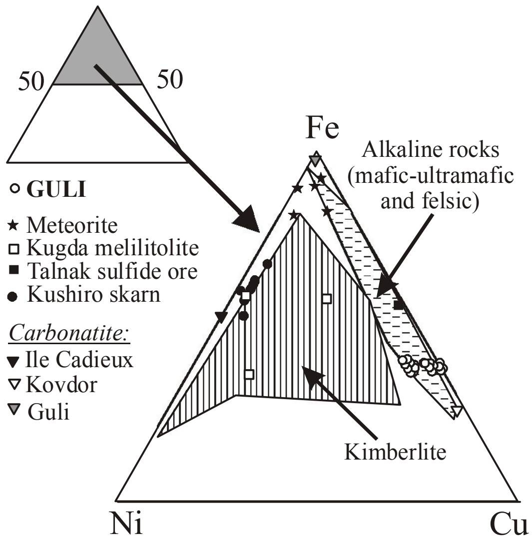

Fig. 2. Compositions of of dierfisherite from the Guli dunite complex in the Fe-Cu-Ni diagram (at%).

Compositional field of djerfisherite from mafic-ultramafic and felsic alkaline rocks and kimberlite are shown for comparison. Individual symbols = occurrence with fewer than 6 reported analyses. Scale bar = 40 μm.

perature ranging from 1000°C to 500°C [2]. Only in two cases, djerfisherite was classified as a secondary mineral formed at the expense of magmatic pentlandite during serpentinization [7] and of primary pyrrhotite because of the infiltration of C-poor fluids during a contact metamorphism near 700°C [8]. Our data show that in the Guli complex, djerfisherite occurs within a phlogopite.magnetite-rich clinopyroxenite stock emplaced along the edge of the dunite core complex. The giant dunite complex of Guli is believed to be the result of successive fractional melting of an ascending mantle plume under metasomatic conditions [9]. The clinopyroxenite stocks and dykes are possibly derived from a fractional melt portion of the ascending mantle plume, that had intruded at the periphery of the dunite complex. Djerfisherite and the associated sufides are part of the accessory assemblage (phlogopite, perovskite-group mineral, apatite, calcite, titanite, plagioclase, zircon, and pyrophanite) formed as a result of this metasomatic event that affected the Guli dunite. The compositional similarity of the Guli djerfisherite with those from alkaline rocks support our proposal that the metasomatic fluids had an alkaline signature.

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THE CHROMITITES AND THE ASSOCIATED PLATINUM-GROUP MINERALS (PGM) OF THE SANTA ELENA OPHIOLITE (COSTA RICA): FIRST AND PRELIMINARY RESULTS

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INTRODUCTION

The composition of chromite from chromitite deposits can be used successfully as an indicator of magma composition [1,2] and geodynamic setting of the host mafic-ultramafic rock. Due to its chemical stability, chromite is well resistant to low temperature alteration processes, therefore is par-