IMPACT ORIGIN OF THE DIAMOND-BEARING KUMDY−KOL DEPOSIT (N. KAZAKHSTAN).

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Introduction: Any collisions of extraterrestrial bodies with the Earth leave "signatures" on the Earth surface. There are also a large number of "signatures" of the impact event, along which it is possible to trace the history of the Kumdi-Kol deposits formation. The main signature is an ring structure with a diameter of ~ 4 km, in shape and size comparable to a small impact crater which geographic coordinates are: N 53^{O}08'20 "and E 68^{O}57'30", the size of the deposit is 1300 x40-200 m and the depth is about 300 m. The impact event was followed by progressive, regressive metamorphism and metasomatic changes in target rocks, that became the causes of the nucleation, growth and conservation of diamonds [1].

Feasible scenario of impact event: Diamond-bearing deposit started to form on the peak of UHP metamorphism provoked by comet impact under oblique angle on the Earth surface. Comet core was consisted from chondritic matter with abundance of carbon and possible nano-diamonds, having abnormal value of noble gases (He, Ne, Ar, Xe) + IDPs (SiC, graphite and diamonds with high contents of noble gases) + carbonaceous matter presolar grains, including diamond and graphite, SiC, Si_3N_4, Al_2O_3, $MgA_{l2}O_4$, $CaAl_{12}O_{19}$, TiO_2, $Mg(Cr,Al)_2O_4$, silicates, TiC, Fe-Ni metal, noble gases and trace elements. These evaporated comet substance under high pressure was injected into previously metamorphic host rocks appeared to be impact-cosmogenic source of diamond seeds and/or nanodiamonds. Water-vapor comet cloud with H_2O, C, CH, CH_4, CN, HCN gases and fine dispersed comet core, survived during comet passing through Earth dense atmosphere, mixed with vapor and melting target rocks and produced complicated carbon saturated vapor-fluid−melt that was a source of diamond growth on carbonaceous matter seeds imported by a comet (likewise plasma-assisted CVD growth technique).

Signatures of impact metamorphism: Collision of huge velocity comet and the Earth had been caused of rapid shock wave compression (pressure peak > 50 GPa) and multiple complex mineral transformation, among them: 1. Presence of UHP minerals: diamond↔lonsdaleite, coesite, omphacite. Microdiamond (~10 - 50 μm size), graphite and coesite crystals distributed within the grains of all rock-forming minerals, fractures in rocks and minerals; 2. Delivering moissanite (SiC) and graphite spheruls, meteoritic matter: magnetite, iocite (FeO), troilite (FeS), ∝-Fe, Ni-Fe by comet; 3. Annealed metallic globules having various fanciful forms in host rock and rock-forming minerals; 4. Dislocation and birefringence in diamonds, planar structure in quartz, inclusions UHP minerals in rock-forming minerals.

Signatures of progressive, regressive metamorphism and inclusions in diamonds characterized by specific rock minerals associations; high concentrations: Na, Ti in garnets, K, Na in clinopyroxenes, K in amphiboles, Al, Si in titanite, Al in phengite; cation's exchange in shock-activated phases $2Al^{3+} \rightarrow [(Mg, Fe)^{2+}+Ti]$ or $(Ca+Al) \rightarrow (Na+Ti)$ in garnets, $Si \rightarrow (Mg^{2+} + Na + Al^{3+})$ in clinopyroxenes; solid phase transformations in host rock minerals; intensive metasomatic alteration of diamond-bearing rocks. Inclusion compositions in diamonds have similarity to extraterrestrial matter. High and low pressure mineral inclusions in zoned garnets and zircons from rock-forming minerals are present [1, and references in it].

Carbon, Helium, Nitrogen, Hydrogen and Nickel in diamonds: Carbon represents by graphite, diamond↔lonsdaleite, chaoite, α- and β-carbines, X-ray amorphous skeletal forms. Diamonds have different forms: cubes (dominated), distorted forms, skeletal and spheroid crystals, octahedra, twins. Core and rim of diamond crystal differ on morphology and C and N isotope compositions. Symplectite-like diamond-graphite intergrowth, coated diamonds with graphite rim and graphite crystals are observed. Diamond carbon isotope composition of $\delta^{13}C$ (–8.9 to –27 ‰) compare with $\delta^{13}C$ (−5 to −31 ‰) in meteorites; carbon matter composition compared with those presolar nanodiamonds.

$^3He/^4He$ isotopic ratios ($7x10^{-1}$ to $8x10^{-9}$) of diamonds from Kumdy-Kol deposit are significantly higher than $^3He/^4He$ ratio of IDP_s (> 10^{-4}), the Earth's atmosphere ($1.4x10^{-6}$), Solar wind ($4.3x10^{-4}$), MORB ($1.1x10^{-5}$), OBI ($0.7x10^{-4}$). ^3He occurs in diamond lattice and inclusions, it means that ^3He was trapped by diamonds during its formation outside the Solar System, more likely ^3He is primordial galactic component. ^4He, Ne, Ar, Xe also present in these diamonds.

High nitrogen (up to 10000 ppm) with high enriched $\delta^{15}N$ (+5.3 to + 25 ‰), N aggregation state is Ib+IaA (Ib > IaA). High hydrogen in diamonds compared with value of coma comet gases (CN, HCN), diamonds from chondrites and presolar diamond grains. Presence of Ni-N defects in diamond lattice identified by PLS. Small diamond sizes, low N aggregation state and diamond preservations suggest to short-term of diamond grown process.

References: [1, and references in it] Tretiakova L. I. & Lyukhin A. M. (2017) Impact−Cosmic−Metasomatic Origin of Microdiamonds from Kumdy−Kol Deposit, Kokchetav Massiv, N. Kazakhstan. *11th International Kimberlite Conference.* Extended Abstract No 11IKC-4506.