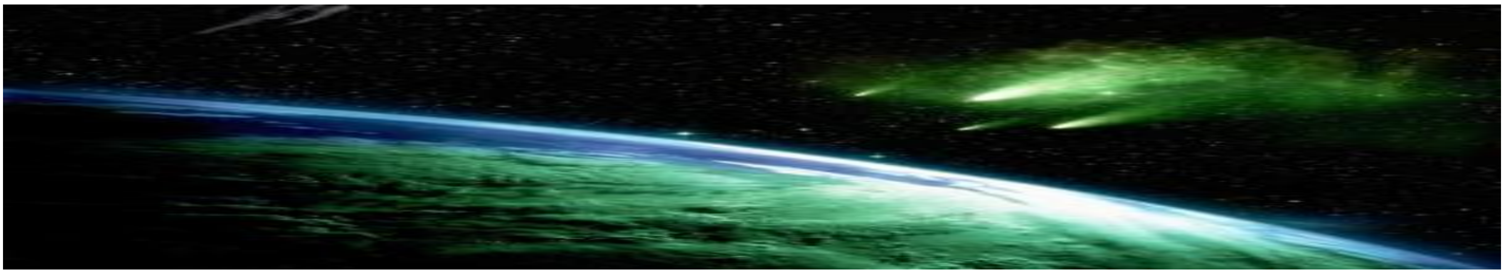

COSMIC-IMPACT-METASOMATIC HYPOTHESIS of KUMDIKOL DIAMOND-BEARING DEPOSIT ORIGIN

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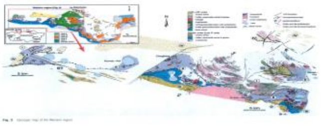
Introduction: Multiple impact events came to pass on the Earth history and they played not only negative character, being causes of catastrophes, but positive influences as well, delivered a lot of useful elements and minerals on the Earth: Diamonds, REE, Pt-, Au-, Ag-, Fe-, Ni-, Cu-ores, oil, gas and so on. One important question - What is diamond origin - Superplumes, Supercontinents or Supernovae?

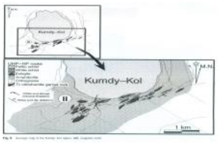
We believe that all diamonds that have been found on the Earth related to extraterrestrial objects and either carried on the Earth with any meteoroids, or grown in situ within an environment created by any meteoroid impact and its explosion. Kumdykol diamond-bearing deposit, Kokchetav massif, N. Kazakhstan is one of the best-known metamorphic diamond localities among numerous UHP terrains around the world. There is a hypothesis suggesting that diamonds from Kumdykol massive crystallized from C–O–H fluid during UHP metamorphism of metasedimentary rocks subducted to 190–280 km in mantle depth. We refute this statement considering geological, petrological, mineralogical features of the deposit, its host rock, diamonds, and impact event evidences caused to big microdiamond deposit formation. The KumdyKol deposit alone host reserves in excess of 2500 million carat, which is greater than all known diamond reserves worldwide; it has average diamond grade 19 - 27 carat/ton.

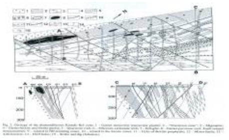
Now, we are offering new cosmic-impact-metasomatic hypothesis of Kumdykol diamond-bearing deposit origin.

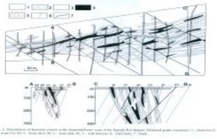
1. Impact Event "Signature": Any collision extraterrestrial body and the Earth had left behind the "signature" on the Earth's surface, one of them is Kumdykol diamond-bearing deposit, Kokchetav massif, N. Kazakhstan located within ring structure about 4 km in diameter [Lyukhin, 2012].


Ring structure KK deposit



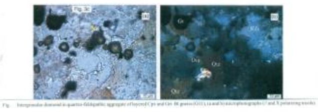


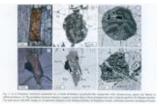


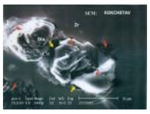


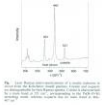
2. Geology of Deposit: Diamond-bearing domain has complicated lenticular-bloc structure (1300 x 40-200 m size) and lens out with deep (about 300 m). Host rocks are garnet-biotite gneisses (dominated), with discontinuous lenses of eclogite, marble, and garnet pyroxenite rocks. High abundances of U, Au, Ti marked in the host rocks. The feature of diamond-bearing rocks is its strong metasomatic alteration that governed by steep falling system of tectonic dislocations, which created breakage and fracture zones filling out of host rock breccia with blastomylonitic and blastocataclastic textures [Pechnikov, Kaminsky, 2008, Vishnevsky, 2011]. These metasomatic host rock zones developed at the expense of all varieties of regionally metamorphosed (amphibolite-facies) rocks with relics of UHPM mineralization, with the strongest contrast revealed in a gneissose substrate (Pechnikov 1993, Pechnikov & Kaminsky 2008). Diamond-bearing rocks represented by dominated garnet-biotite gneisses which have more abundance of graphite, sulfur, water, REE, (beside diamond-free gneisses on deposit periphery) (Lavrova et al., 1999) and lenses of carbonate, chlorite-tremolite-quartz, garnet-pyroxene rocks, altered eclogites, that interchanged with diamond- and graphite-free rocks. Diamonds occur in all minerals and rocks within ore zone

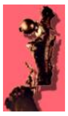
3. Mineralogical & Geochemical Features of Diamond: Microdiamond crystals (~10 - 50 мк size), graphite and coesite occur in intergranular interstices; within the grains of all rock-forming minerals, and conform syngenetic intergrowth with rock-forming minerals, that containing nano- inclusions derived at high-pressure and retrograde metamorphic conditions. Diamond, graphite, and coesite distribution is not random but tends to be associated with fractures in rocks and rock-forming minerals, including secondary minerals. Diamond grains formed chains and clusters along the fractures. Diamondiferous clusters are morphologically variable: five to ten microcrystals may form 2D patterns; 3D botryoidal aggregates are observed as well. Syngenetic polycrystaline nano inclusions in diamonds represented by oxides Si, Ti, Fe, Cr with trace element impurities of Mg, Ca, Al, K, Na, S, P, Pb, Nb, Cl, Zn, Ni, and Ca-Ti containing zircon, ThxOy, $BaSO_4$ [Dobrzhinetskaya et al., 2003], Si-P-K-containing glasses with high abundance Si, low abundance K, and K-Si-fluid inclusions [Hwang et al., 2006]. Planar structures in quartz, presence coesite inclusions, finding SiC, inclusions of meteoritic substance (magnetite, iocite, troilite, plessite) with various fanciful forms (globules, small dump-bells, drops, spherules) Зейлик Б.С.,1997 observed in metamorphic host rocks have point out to the passing through these rocks shock wave with peak pressure ≥ 50 kbars or higher and injection of evaporated meteoroid substance into host rocks target fractures, provoked by impact of comet, which core was, possibly, consisted from chondritic matter [Koeberl, 2002]. All of above are important evidences of Impact Event.









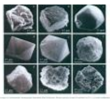


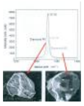
Meteorite Metal Particles

4. Carbon Characteristics: Carbon, besides cube (diamond) and hexagon (graphite) modifications, represents transition forms with diamond structure, lonsdaleite, chaoite, alpha- and beta-carbines, X ray amorphous skeletal forms. Diamonds have small sizes (20-40 µm), significant part of them located in fractures of rock-forming minerals and intergranular spaces between minerals. Diamonds have different morphologies: cubes (dominated), octahedra, distorted forms, skeletal and spheroid crystals, twins. Diamond crystals have dislocations, abnormal birefringence and high impurity abundance. Syngenetic diamond/graphite growth, coated diamonds with graphite rim and graphite crystal are observed [Шумилова, 1996]. Carbon matter composition compared with those presolar nanodiamonds. All of above suggest of high shock pressure (lonsdaleite), carbon saturated medium, where occurred very high rate of multiple diamond generation under sharp, changeable P-T conditions.

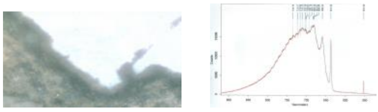
Values of diamond carbon isotope composition of б13C (–8.9 through –27‰) compare with б13C (-5 through -31‰) in meteorites. Diamonds from various rocks are differentiated of their carbon isotopic pattern: diamonds from gneiss have lighter isotopic compositions relatively to those of pyroxene-carbonate and garnet-pyroxene rocks. Values of graphite carbon isotope composition of б13C are lighter than those in diamonds [Pechnikov,Kaminsky, 2008], that do not supported the hypothesis of transformation graphite to diamond for this deposit. Varieties of carbon modifications and its isotopic compositions suggest to discrete carbon sources.

Diamond




Dia. Raman Sp.


Diamond crystal cores with graphite & their PLS


Dia. crystal edge coated by graphite & its PLS

5. Helium Characteristics: The helium in diamonds has extremely high isotope ratio, ^{3}He occurs in diamond lattice and inclusions (more abundance, then in the lattice) in diamonds, it means that ^{3}He was trapped during diamond formation outside Solar System [Huss, 2005]. ^{3}He/^{4}He ratio (3.3–6.5)$x10^{-5}$ of Kumdykol diamonds is significantly higher than ^{3}He/^{4}He ratio of Earth's atmosphere (1.4$x10^{-6}$), solar wind (13.7$x10^{-6}$), and MORB-source mantle (1.1$x10^{-5}$)[Sumino et al., 2011], presuming that ^{3}He more likely primordial galactic component.

6. Nitrogen Characteristics: Latter conclusion supported by high nitrogen content (up 3300 ppm) and values of isotope ratio 6^{15}N (+5.3 through +25‰) in diamonds compared to those of comet coma gases (CN, HCN), diamonds from chondrites and presolar diamond grains. Diamond preservation, sizes, low nitrogen aggregation state (Ib +1aA) depend from sharp decreased pressure and gradual thermal cooling conditions that suggest on short-termed Kumdikol diamond growth process.

Conclusions: The above evidences allow reproduce geologic history of Kumdykol diamondiferous deposit: Diamond-bearing zones have been started to form on the peak UHP metamorphism, provoked by comet impact under oblique angle on the Earth. Shock wave with peak pressures of 50 kbar or higher was passed through host rock target. Comet core was, possibly, consisted from chondritic matter [Koeberl, 2002] with abundances of nano diamonds, having abnormal values of noble gases (He, Ne, Ar, Xe) + IDP (diamonds, SiC, graphite with high anomalous C, noble gases, and ^{26}Mg from the decay of extinct ^{26}Al.) + presolar grains (carbonaceous matter (including diamond and graphite), SiC, Si_3N_4, Al_2O_3, $MgAl_2O_4$, $CaAl_{12}O_{19}$, TiO_2, $Mg(Cr,Al)_2O_4$, silicates, TiC, Fe-Ni metal, noble gases and trace elements [Clayton, 2004]), and comet coma (saturated CN, HCN gases). Evaporated comet substance was injected under high pressure into previously metamorphic host rocks target, appeared impact-cosmogenic source of diamond nucleuses and/or diamonds themselves. Remains of water-vapor comet cloud (with H_2O, C, CH, CH_4, CN, HCN gases) and fine dispersed comet core meteorites matter, survived due comet passing through dense air layers, as result of impact, mixed with vapor and melting target rocks and produced complicated composition fluid-melt (de Niem, 2002), that was a source of epitaxial diamond growth on carbonaceous matter seeds imported of a comet. After impact event, fluid-melt also facilitated metasomatic alterations of target host rocks at conditions of sharp drop pressure and gradual temperature decreasing (regressive metamorphism) that traced on inclusion composition of different zones of zircons [Katayama, 2000, 2002, 2009, Okamoto et al., 2006, Hermann et al., 2001] and garnets [Parkinson et al., 2000] from host rocks.

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