Geochronology Archaean Kolmozero-Voron'ya greenstone belt of the Kola region (north-eastern Baltic shield)

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The Kolmozero-Voron'ya greenstone belt is one of the most ancient geological structures of the Kola Peninsula. It is located between Upper Archaean terrains: Murmansk, Central Kola and Keivy. Within the Kolmozero-Voron'ya greenstone belt there are rare metal (Li, Cs with accessory Nb, Ta, and Be), Cu, Mo, and Au deposits. All rocks were metamorphosed under amphibolite-facies conditions and intruded by granodiorites, plagiomicrocline and tourmaline granites and pegmatitic veins. Four suites are distinguished within the belt: lower terrigenous formation, komatiite-tholeite, basalt-andesite-dacite and upper terrigenous formation. The U-Pb age of 2925±6 Ma on magmatic zircon was obtained for leucogabbro of differentiated gabbro-anorthosite massif Patchemvarak, situated at the boundary between volcanic-sedimentary units and granitoids of Murmansk block. Sm-Nd age of komatiites is ca. 2.87 Ga (Vrevsky, 1996). U-Pb age of zircon from biotite schist, which belong to acid volcanites is 2865+/-5 Ma. Quartz porphyries, which are considered to be intrusive vein analogous of acid volcanites has an age of 2828+/-8 Ma, that marks the final stage of the belt development. Dating of titanite from ovoid plagioamphibolites yielded an U-Pb age of 2595+/-20 Ma that probably is connected with the closure of the U-Pb isotopic titanite system during the regional metamorphism. The Porosozero granodioritic complex, which intruded volcano-sedimentary rocks of the belt has an age of 2733+/-6 Ma. Tourmaline granites are found all over the Kolmozero-Voron'ya belt occurring among volcanogenic-sedimentary rocks of the belt. Their Pb-Pb age of 2520+/-70 Ma appears to denote the tourmaline crystallization at a post-magmatic stage of the complex formation. Preliminary age of rare-metal pegmatites is 1.9-1.8 Ga.

Thus, several stages can be distinguished in the evolution of the Archaean Kolmozero-Voron'ya greenstone belt: protoocean with komatiite-toleite magmatism (3.0-2.9 Ga); volcanic arc with andesite-rhiolite magmatism (2.9-2.8 Ga); regional metamorphism and granitization with melting of granodiorite-granite magmas (2.7-2.6 Ga); regressive metamorphism and potassium metasomatism with the formation of tourmaline and microcline granites and rare-metal pegmatites within and outside the belt (2.5-1.8 Ga).

Tectonics, Weathering, Atmospheric CO_2 and C Burial during the Mid-Miocene Climate Change

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The Mid-Miocene denotes the transition from the warmest period of the last 35 Ma, the Miocene climatic optimum, to the modern Late Cenozoic cool mode. Modifications of the rate of mountain building, the growth of the East Antarctic Ice Sheet (EAIS), sea level, deep ocean circulation and carbon cycling took place. In order to explain the Miocene climate shift, two hypotheses have been put forward: (a) marine carbon removal, and/or (b) increased silicate weathering as a result of tectonic uplift of the Himalayas. Both mechanisms may have resulted in atm. CO_2 reduction and global cooling. However, despite the occurrence of prominent changes mentioned above, CO_2 predictions based on marine geochemical proxies across the Miocene climate shift suggest consistently low CO_2 since the Early Miocene. Stomatal frequency analysis on fossil leaf remains represents a robust biosensor to test independently CO_2 prediction based on marine proxies. Well-preserved laurel, Ginkgo and oak leaf remains were studied from several Early and Mid-Miocene brown coal deposits in Germany and the Czech Republic. The initial high CO_2 values of about 500 ppmv correlate with the early part and climax of the Miocene climatic optimum. CO_2 starts to decline approximately at the beginning of the marine _^{13}C excursion at ~17.5 Ma. CO_2 is about 300 ppmv during the initiation of the general cooling at about 15 Ma. CO_2 continues to decline to a minimum of about 250 ppmv during the main EAIS expansion and rises again to values similar to the present day level around 12 Ma. Perhaps the most striking feature of the stomata based CO_2 reconstruction is that the main phase of CO_2 depletion occurs during the Miocene climatic optimum. In one respect, this is the expected consequence of weathering enhanced by accelerated Himalayan uplift, warmth and an intensified hydrological cycle. However, if CO_2 were a dominant climate determinant, one would expect that cooling should have accompanied the CO_2 drawdown. Decoupling suggests that other climatic factors temporarily compensated for the diminished greenhouse effect of CO_2. A reduction in ice sheet coverage is one possibility. The combination of an accelerated uplift of the Himalayas, warming and a more active hydrological cycle may have caused the CO_2 decrease. The initiation of EAIS expansion may have required a CO_2 threshold of ~ 300 ppmv at 15 Ma. The subsequent increase in atmospheric CO_2 may have been the result of a decrease in silicate weathering commensurate with coverage of silicate weathering terrains by ice sheets and mountain glaciers.