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# Popigai Impact Event: Global or Regional Catastrophe?

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The evaluation of damage degree and its extent caused by major asteroid impacts in the geological past usually based on the long-living geological record. The diameter of ancient crater and character of disturbed and transformed target rocks, the character and distribution of impactoclastic deposits, paleontological data of biotic changes and their extent are the main data sources of this evaluation.

The best documented examples of terrestrial impact events which have produced global catastrophes are the formation of the Chixulub crater, originated at the K/T boundary and Vredefort and Sudbury craters of Proterozoic age. These craters with diameters about 200-300 km were caused by collision of projectiles with diameter larger than 10 km. Some authors supposed that impact of the projectile with diameter slightly larger than 1 km may have a global consequences as well. It is interesting to evaluate the scale of damage during the formation of an impact crater two or three times lesser in diameter than mentioned above. It may be done using the data regarding to the Popigai crater in central Arctic Siberia.

It has diameter 100 km and was formed 35.7±0.2 Ma ago by the collision of an asteroid, which was about 7 km across [1].. Paleogeographical reconstruction shows that the territory where the impact event occurred at the end of Eocene (Priabonian Stage) was relatively flat and was covered by forest vegetation of a transition type from subtropical to moderate thermophilic [2]. The crater depression is filled in with lithic impact breccias and impactites, resulting from destruction and melting of a two-layered target made of crystalline basement and a platform cover. The complex impactite layer has a maximal thickness 600 m, the composed rocks contain impact diamonds formed by shock transformation of graphite embedded in target gneisses [1]. The energy of the impact may be evaluated as equivalent to $E=2.10^{7}$ Mt of TNT, peak pressure at the compression stage of $P=6.24.10^{11}$ Pa, and seismic magnitude at the point of impact of 8.3-9.5 on the Richter scale [1, 3]. The zone of complete destruction of target rocks during cratering may be divided into three subzones: evaporation (R~9.5 km), melting (R~11.3 km), and intensive deformation (R=50 km), respectively. The ballistic ejecta, seismic wave, thermal radiation caused by fireball, blast wave in the atmosphere, high-velocity wind and dust clouds were responsible for the principal damage outside the area of complete destruction. Several zones of decreasing damage with distance from the impact point may be reconstructed by means of evaluated impact energy [3, 4], local setting and geological data.

The near crater zone of severe damage was about 1,500 km in diameter. This zone characterized by thermal radiation which caused wildfires and strong burns and extended to the central and northern parts of Eastern Siberia, parts north-east of Western Siberia, north-west of the Verkhojansk range, and a part of the Arctic ocean. This zone may be subdivided into three concentric subzones. At a distance of about 100 km or more from the impact point intensive ground displacement, very strong air blast, incineration due to fireball radiation, base surge, and ejecta fallout occurred. The observation of topographic features shows the strong modifications of drainage system due to block displacements and ejecta fall. Some relics of the pre-impact valleys on the present topographic divide may be distinguished [5]. Remnants of the ejecta blanket are preserved out to a distance of 70-80 km from the crater center [1], but ballistic ejecta originally had extended out to 500 km; it argues by the distribution of impact diamonds scattered in the river beds and caused by destruction of ejected diamond-bearing material [1, 6].

The block displacements and fallout ejecta may strongly disturb the primary gravel spread containing kimberlite diamonds and located at the distance about 100-150 km to the south-east from the crater in the Anabar river basin. The modern diamond-bearing deposits containing small rock fragments and redeposited pollen of Paleogene thermophilic plants occur in the form of gravel pipes and cover of ancient terraces [6]. The placer kimberlite diamonds are accompanied by impact diamonds. Probably the modern placers arised due to redeposition mixing of two sources: the primary pre-impact gravels with kimberlite diamonds and fallout breccia which carried impact diamonds.

The zone of moderate or light short-term damage of biotic systems may embrace northern Eurasia and a significant part of the adjoining Arctic ocean down to the modern northern coasts of Greenland and Canadian archipelago. The deforested land of this zone produced by violent storms probably propagated to a distance of about 2000 km, and areas of slight damage to the vegetation caused by storms and strong gales may have reached to distances up to 2500 km. Some disturbances caused by seismic-generated tsunamis and gales may have occurred on the ocean coasts up to 3000 km. The influences of global long-term factors of damage are studied insufficiently. It is known that considerable biotic change at the end of Eocene did not occur. The global cold snaps (about 4-5$^{o}$ C) and biotic changes took place at the Eocene/Oligocene boundary, and is considered as the result of common climatic change, but it might have been enhanced due to blanketing of the atmosphere with dust. In the part of Siberia under review the species of forest vegetation occurred became less thermophilic [3].

Nevertheless, the weak influence of the Popigai event may be traced to a distance of more than 15,000 km based on the distribution of dust carried by atmospheric or gas currents. The fine spheroids of impact melt (microkrystites) and particles of shocked minerals are found in the Late Eocene deposits in Italy, in Spain, in deep drill holes in subequatorial area of world oceans and in the southern part of Atlantic ocean [7, 8, 9, 10]. The bulk composition of Popigai impactites and tiny spheroids (microkrystites) recovered from the drill holes are similar [1, 9]. Moreover, isotope measurements of particles and spheroids and their dating compared well with data on impactites from the Popigai crater [11].

In general, the intensive and moderate damage areas caused by the Popigai event covered only about 5.5 % of the Earth's surface. Taking into consideration the absence of evidences of a world-wide effect, the Popigai event occurred in the continental setting could not have produced a global catastrophe, but gave rise to rather significant regional effects and destruction. No doubt, the evaluation of intensity and extent of damage caused by this event needs additional investigation and especially careful study of respectively stratigraphic sequences close to the impact point as well as in distant areas.

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