THE KARA IMPACT STRUCTURE: Nd-Sr ISOTOPIC COMPOSITION OF AN IMPACT MELT. M.A.Nazarov (1), S.F.Karpenko (1), A.V.Ljalikov (1), M.I.Smylyar (2), E.M.Kolennikov (2) and L.D.Barsukova (1) - (1) Vernadsky Institute of Geochemistry and Analytical Chemistry of Russian Academy of Sciences, Moscow 117997; (2) Moscow State University, Geological Faculty, Moscow 119899, Russia

The Kara structure has been suggested [1-3] as a possible K/T impact crater. Therefore the structure could be a source for the K/T boundary impact glasses discovered at Beloc, Haiti [4,5]. Geochemical considerations [6] have shown that the glasses could be formed from the Kara target. In this paper we try to solve this problem using Nd-Sr isotopic systematics because Nd-Sr data have been used successfully to recognize potential source materials for tektite glasses [e.g.7]. So we measured Nd-Sr isotopic compositions of a Kara impact melt and compare then with Nd-Sr data on the K/T glasses published in [8].

Sample and methods. Most of Kara impact melts have a chemical composition of Permain turbidites which dominate in the target and are similar in their chemistry to the K/T glasses [6]. For this reason we analyzed an impact melt ANO-102,0 which has a Permian composition (SiO2 60.93; TiO2 .94; Al2O3 15.65; Cr2O3 .035; FeO 6.97; MnO .109; MgO 5.20; CaO 3.90; Na2O 2.82; K2O 2.22; P2O5 .21; LOI .77, wt.%). The sample was collected from a 10 m thick impact melt body at the Anaroga River, 32 km SE of the crater center. It can be suggested from the bulk chemistry that the impact melt was formed from both sandstone and shale components of the Permian deposits. The sample was crushed up to the .25-.5 mm size fraction and fresh fragments were picked up for the Nd-Sr analyses. All the analyses were done in the Vernadsky Institute and Moscow University using usual for these labs techniques [9,10].

Results. Obtained Sm-Nd and Rb-Sr characteristics for the Kara impact melt are listed in the table and shown on the εNd(0)-εSr(0) diagram.

<table>
<thead>
<tr>
<th>87Rb/86Sr</th>
<th>87Sr/86Sr</th>
<th>εNd(0)</th>
<th>Tdm(Sr)</th>
<th>εNd(0)</th>
<th>Tdm(Nd)</th>
</tr>
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<tbody>
<tr>
<td>.6089+/- .01</td>
<td>.70916+/- .01</td>
<td>+62.6</td>
<td>.60 Ae</td>
<td>.1310+/- .1</td>
<td>.51180+/- .4</td>
</tr>
</tbody>
</table>

Uncertainties correspond to the last significant figure(s) at the 95% confidence level. Parameters used for calculations of ε and Tdm values are: 87Sr/86Sr(UR)=.70475; 87Sr/86Sr(DM)=.7026; 87Rb/86Sr(DM)=.046; 143Nd/144Nd(CHUR)=.51184; 143Nd/144Nd(DM)=.51285; 147Sm/144Nd(DM)=.217

Discussion. Obviously the Nd-Sr isotopic characteristics of the Kara impact melt reflect those of the Permian source sediments and should be compared with Nd-Sr systematics of sedimentary rocks. In general most of Phanerozoic recycled sediments are lower in εNd and higher in εSr as compared with the Kara melt (Fig). For this reason the melt has younger Tdm(Sr) and Tdm(Nd) model ages relative to the Phanerozoic sedimentary rocks which show Tdm(Nd) ages in the range of about 1.5-2.0 Ga [11]. As it can be seen from the Fig., Nd-Sr isotopic compositions of the Kara sample are rather close to those of some modern turbidites (marked with stars) for which a presence of mantle-derived components has been postulated [11]. The same explanation can be applied for the Kara melt because a contamination of the Permian source turbidites with mantle-derived components has been demonstrated by geochemical studies [12]. In this case the Ural mountains were considered as a source area for these components because the Permian sediments of the Kara region are composed mainly of a material eroded from the mountains.

The K/T Haiti glass is suggested to be formed from sedimentary rocks [4]. The glass has εNd(0)=-3.4 and εSr(0)=65.5 [8] which are in the turbidite field and close to those of the Kara sample (Fig). Tdm(Nd) and Tdm(Sr) model ages of the K/T glass are equal to 1.2 and 1.4 Ga respectively. Therefore it can be suggested that some turbidites containing mantle-derived components can be the source rocks for the K/T glass. This conclusion is compatible with geochemical data on the glass and confirms a presence of a mantle-derived material in the K/T ejecta that has been shown earlier by Nd-Sr isotopic studies of the K/T clay [13].

Thus the K/T glass and the Kara melt show similar Nd-Sr characteristics suggesting that the Kara target could be a possible source for the K/T glass. However the K/T glass is lower in εNd and higher in Tdm(Nd) that indicates its relative enrichment in the upper crust material when compared to the Kara melt. These melts have also very different Tdm(Sr) ages at the similar εSr value. The Kara sample displays Tdb(Nd)>Tdb(Sr) that is a typical case resulted from selective enrichment of Rb in clay minerals formed during sedimentary processes which do not change RRE proportions. In contrast the Haiti glass shows Tdb(Sr)>Tdm(Nd) that demands a selective
loss of Rb from the glass or a contamination of the glass with a 87Sr-high and REE-poor component. These differences are important but they do not conflict with the possible relation between the Kara crater and the K/T glass. In fact the Permian turbidites are variable in their composition (6,12) and, hence, they should contain various proportions of mantle-derived and upper crust components. Therefore Nd-Sr isotopic compositions of the rocks should be also variable and should be controlled by mixing of the principal components. So the Nd-Sr isotopic compositions of the K/T glass can be compatible with those of the Permian turbidites. The unusual Tdm(Sr)/Tdm(Nd) ratio of the K/T glass could be a result of impact mixing of the Permian turbidites with a carbonate material which is abundant in the Kara target and should have high 87Sr and low REE contents. Alternatively the ratio can be explained by a selective vaporization of Rb from the impact melt or Rb leaching from the glass after its deposition in the K/T clay under the marine environment.

Thus we can conclude from the Nd-Sr study that Kara could be a source crater for the K/T Haiti glass and also for the mantle-derived component of the K/T ejecta identified in the K/T boundary clay. Therefore the Nd-Sr study does not contradict to the possible link between the Kara and the K/T impact events.