SHOCK VAPORIZATION OF GRANITES: EXPERIMENTAL RESULTS.
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Experimental study of geochemical consequences of hypervelocity impacts into granites can give important information about evaporative trends of granite type silicates during impact processes. It must be mentioned that granites is a typical target for most of Earth astroblems. It also can be useful for evaluation of evolutionary trends of planetary matter during the final period of formation of earth type planets, because at that time these planets could have a protogranite (or mostly feldspar type) crust.

In a set of experiments we have studied the composition and chemical structure of condensed films which were precipitated from a vapor during hyper-velocity impacts. We used the light gas gun of Mechanical Institute (Moscow State University). Details of experimentation are described in [1]. Here we present results of 2 shots into acidic rocks. In the first experiment we shot with a copper projectile into obsidian target at a speed of 5.7 km/s. Mass of the spherical copper projectile was 0.545 g and pressure of air inside the target chamber was 44 torr. For the second experiment we have made a spherical projectile from a kamasite of Sikhote-Alin iron meteorite (mass - 0.493 g) and shot it into a granite target with a speed of 5.6 km/s. Air pressure in a target chamber during the second experiment was 46 torr. At a distance of 6-8 cm from the center of impacts we have mounted special screens to collect a vapor which could originate during impacts. The thickness of condensed film was 1000+2000 Å. The total mass of vapor during the impact was calculated to be about 20 mg. Chemical composition of targets and of relevant condensed films are shown in the Table. Analyses of obsidian and of its condensed film was made using SIMS technic. Analyses of granite and of its condensed film was made using XPS technic (for details see [2]).

Results presented in the Table indicate that impact vaporization proceed as a process of selective volatilization. Chemical composition of condensed matter is noticeably different from composition of target material. The volatility of elements in this experiments do not follow a usually expected sequence of volatility of pure oxides. Concentration of normally refractory oxides, such as CaO, TiO₂, Al₂O₃, in condensates is higher or the same compared to target material. But concentration of moderately volatile silicon in condensates is noticeably lower then in target material. Individual volatility of K₂O is higher than of Na₂O but in condensates concentration of K₂O is depleted and concentration of Na₂O is noticeably enriched compared to target. The ratio of K₂O/Na₂O was decreased from 0.95 in obsidian to 0.23 in condensate and for granite the same ratio was decreased from 1.74 to 0.12.

The reason of this not expected sequence of elements volatility we see in a cluster mechanism of vaporization under high temperature and pressure conditions. In this case a relatively large silicate molecules can be stable during vaporization giving a transport to vapor phase for some elements in a stoichiometrical proportion of a molecule. Some other examples of not expected sequence of volatility of elements which are also guessed to be of the same cluster type vaporization are described in [3,4,5]. Another not direct confirmation of a possible role of a cluster mechanism of vaporization during high-temperature pulse processes is the presence in condensates in this case of a noticeable portion of matter with silicate structure [6] while condensed films which are produced during thermal vaporization in vacuum have a pure oxide structure. Results of our experiments coincides with conclusion of Nagahara [7] about incongruent vaporization of plagioclase (albite in particular) which proceeds with a formation of vapor of nepheline composition and with an enrichment of silicon in residua melt. Chemical compositions of nepheline-syenite, feldspar urtite and nepheline is presented in the Table for comparison with composition of condensates which were produced in the experiment. The chemical trend of impact vaporization of granites towards nepheline rich silicates is shown on Fig.1. If the mentioned above mechanism of nepheline molecule volatility during impacts is a real process then large scale impacts at the
final stage of the Earth's accretion could produce a noticeable amount of nepheline type silicates.


Table. Chemical composition of acidic targets and of their condensates after hyper-velocity impact experiments (wt. %).

<table>
<thead>
<tr>
<th>Oxides</th>
<th>Velocity 5.7 km/s Target</th>
<th>15.4</th>
<th>4.3</th>
<th>14.3</th>
<th>11.1</th>
<th>0.2</th>
<th>0.3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Obsidian</td>
<td>Condens.</td>
<td>Target</td>
<td>Granite</td>
<td>Condens.</td>
<td>Neph. syenite</td>
<td>Urtite</td>
</tr>
<tr>
<td>Na₂O</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10.9</td>
<td>15.1</td>
</tr>
<tr>
<td>MgO</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.8</td>
<td>0.1</td>
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<tr>
<td>Al₂O₃</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21.3</td>
<td>30.2</td>
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<tr>
<td>SiO₂</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>51.7</td>
<td>43.6</td>
</tr>
<tr>
<td>K₂O</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7.0</td>
<td>5.8</td>
</tr>
<tr>
<td>CaO</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.7</td>
<td>1.4</td>
</tr>
<tr>
<td>TiO₂</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.1</td>
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<tr>
<td>FeO</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5.5</td>
<td>2.9</td>
</tr>
</tbody>
</table>

Fig. 1. Chemical composition of acidic rocks, targets and condensates on a ternary system (Na₂O+K₂O)-SiO₂(FeO+MgO).

- granite
- nepheline-syenite
- urtite
- nepheline
- granite target
- condensate