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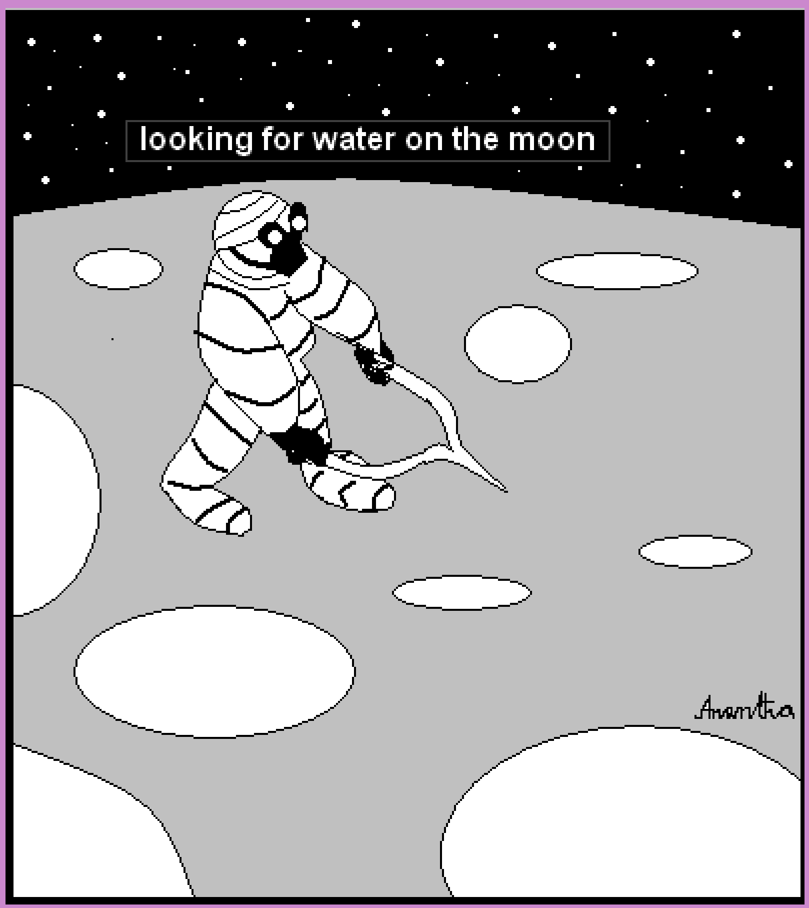
There may yet be water on the moon

Chances of finding water on the moon are looking up says S.Ananthanarayanan.

A group of geologists at Brown University, the Carnegie Institute and Case Western University in USA, have used a hypersensitive technique of analysis to show that the moon started off with water reserves that were similar to those on the earth. There is hence the possibility that some of it is still there, frozen as ice so that it does not evaporate and hidden from harsh heat so that it does not melt.



Weak gravity

When objects grow smaller in dimensions, their volume, and hence their mass, shrinks faster than the dimensions grow small. For instance, a sphere 2 km across has volume of about 4 cubic km. But for a sphere of half the radius, or 1 km across, the volume is only about half a cubic km, which is 8 times less. As less massive objects have less gravity, smaller bodies in the cosmos are not able to hold on to satellites. They are not even able to hold on to their atmosphere!

It is this weak gravity on the moon that has allowed almost all the atmosphere to escape into space. This is the reason that meteorites coming in to the moon do not get burnt up, like they do when they approach the earth, but they strike the moon surface – leaving it full of craters and 'pock-marks'. But it is not only the gaseous atmosphere that has escaped from the moon, everything that is even a little volatile, like water, of course, but even ordinary metals, have evaporated and escaped. The moon is thus left with more of ***refractory*** elements, that is, which survive high temperature, like aluminium, calcium, titanium and less of ***volatile*** elements, which evaporate, like sodium or potassium.

Hence the classic model of the moon is that it formed after a major collision of the earth of 30 million years ago with a Mars-sized object and the moon was ejected with very high temperatures being generated. In this, all but the highest melting things were lost and naturally, all the water. This view of the moon has been confirmed by the samples of moon rock brought back by the Apollo Missions – for the samples showed presence of sulphur, chlorine, fluorine and carbon, but no traces of water.

If there is no water on the moon, it rules out the possibility of most life-forms on the moon and also raises challenges if colonies or outposts are to be set up on the moon.

New discovery

The journal, ***Nature***, this week, has reported results of ultra sensitive analysis of ceramics (fused rocky material) formed during the early part of the moon's history. These ***glass beads***, the most primitive volcanic rock of the moon, would trap and contain a measure of the water content of the early upper mantle, or the layer just below the moon crust. In the case of the earth, analysis of such early glasses, after applying different corrections, shows that the early upper mantle contained some 150 parts per million of water.

Similar analysis of lunar rock samples has been less effective because of two limitations. First, the analyses have been of the content of the whole sample, in bulk. This means it is not possible to say whether any traces found in the sample were there right since the sample was formed or whether the traces came there later, implanted for instance by the ***solar wind***, particles streaming in from the sun. The traces could even be contamination when the samples were handled, here on the earth. The other limitation is that the threshold of trace content that could be detected by existing methods of analysis was quite high. Hence, the negative results of analyses could not rule out the presence of smaller traces of water in the samples.

Mass spectrography

This is a method where individual atoms, which become charged when stripped of some of their components, are sorted by deflection by magnetic and electric fields. It is something like farmers separating grain from chaff by pouring threshed grain from a height while a breeze is blowing. Now, a variation of this method is when a microscopic sample of a material is bathed in a stream of radiation, and the material gives off charged cores of its own atoms. When this emission is analysed using the separating fields, it is possible to detect and separate different elements which are there even in very small quantities.

With this extra sensitive technique, the researchers were able assess the level of traces of chlorine, etc and water, separately at different depths inside the glass pebbles brought back by Apollo missions. The pebbles selected were the ones that showed less traces of metals like nickel, which are typically present in rocks produced during impact of meteorites. The glasses selected were also like the surrounding volcanic material and were clearly the product of volcanic eruptions, the so called ‘fire fountains’ that are known in volcanoes on the earth.

The findings

While the beads were coated with traces of materials that could have come from subsequent meteoric impact, the researchers were able to selectively analyse layers ***below*** the surface, which could not have been reached by external impact. The research showed that the greatest levels of chlorine, fluorine, sulphur and water were at the ***core*** of the beads, which strongly suggests that the traces got there when the bead was formed. Assessments of the water content of the mantle at the time the beads were formed suggest that the water content was similar to that on the earth!

The finding is a convincing sign that at its birth the moon had a lot more water than has been believed. The discovery raises a number of questions, to reconcile a water-rich origin with other geochemical features of the moon and the earth. One question is, “just how did the water all get away?” There is a clear possibility that water, in the form of ice, is there in shady craters at the poles of the moon. This ice would be protected from the scorching heat of the lunar day and may be there even now!