Geophysical Research Abstracts,
Vol. 10, EGU2008-A-11667, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-11667
EGU General Assembly 2008

Comparing the evolution of the Earth, Mars and Titan (Runcorn-Florensky Medal Lecture)

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The knowledge of the Earth's geology drives our interpretation of the data acquired by space missions. In the last ten years, the data returned by orbiters, landers and rovers have changed our understanding of the structure and evolution of planet Mars. The NASA/ESA Cassini/Huygens mission to Saturn has brought outstanding observations of Titan. Both Mars and Titan have similarities with planet Earth. Titan is an icy world with a nitrogen rich atmosphere, dunes, rivers, lakes, mountain ranges and volcanoes. Although the material is different, the processes are similar. Models of Titan's evolution are developed in order to account for the observations made so far. Looking at Titan has returned questions like the role of methane clathrates on the climatic evolution of the Earth and the effect of tidal heating on early Earth just after the formation of the Earth-Moon system.

Mars has been observed by numerous orbiters, landers and rovers. Its atmosphere and its surface are now pretty well known. One can constrain models describing cycles of water, nitrogen and carbon for a planet where plate tectonics may have never existed and where the magnetic field was active during the first hundreds of million years. Models describing the relationships between mantle convection and plate tectonics on one hand and mantle convection and core dynamo on the other hand can now be constrained by comparing Mars and Earth. However a more complete understanding has to await data on the internal structure, which requires the deployment of seismic network on the surface of Mars. Moreover, our understanding on how life formed and has evolved needs to collect samples that will be studied in Earth laboratories.