# REFINING THE SEARCH FOR WATER ON MARS USING BALLOON-BORNE NEUTRON SPECTROMETERS.

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**Introduction:** The search for water on Mars is critical for planning future human missions to the Red Planet. Having a substantial source of acceeable water at an intended landing site will provide life support consumables (atmospheric O2 and crew water) and mission propellant. These two elements (crew water and propellant) represent a substantial mass for any Mars mission and leveraging this in-situ resource can be considered an enabling resource for any human mission to the Red Planet. Locating surface and near-subsurface water remotely on Mars can be accomplished using neutron spectrometers as was done on the Mars Odyssey Mission. Mars Odyssey orbited at an altitude of 400km and provide a global data set of water-equivalent hydrogen (WEH) abundance with a special resolutions on the order of 300km. Orbit-based neutron spectrometers are limited to this resolution range therefore in order to identify high-water content candidate landing sites for a future human Mars mission a higher resolution WEH survey is needed. The use of an air-borne neutron spectrometer flying over the martian surface at an altitude of 2-6km would provide km scale spatial resolutions of WEH. A survey of WEH even in a limited area of the planet would aid both a localized search for Martian water and allow for an educated extrapolation of regional martian water abundance estimates across a region.

**Mission Concept:** The most straightforward approach to increasing the spatial resolution of a remote sensing neutron spectrometer is to fly it close to the planetary surface. On a planet like Mars, this is best accomplished using a balloon with a tethered instrument package. Initial design estimates of mass, power, and mission duration of a martian balloon-borne neutron spectrometer indicate that the payload (spectrometer, framing camera, instrument electronics, solar panels) would be 100-150kg and would consume 5 to 10 watt-hour and have a mission lifetime of 45-60 sols. Deploying two or more of these payloads simultaneously would be preferred to increase mapping coverage of the target region and to increase maximum mission success.

**Conclusion:** A Mars balloon-borne neutron spectrometer as described here is a mission that can be accomplished with Technology Readiness Level (TRL) hardware of TRL6+. This type of mission would be well-suited as a secondary payload on a future mission such as Mars 2020. Assuming deployment on such a mission would place the balloon-borne neutron spectrometer in a region of considered human landing site locations (+/- 30 degrees latitude). Initial estimates of cost and development timelines are in the 10-15M range with hardware delivery possible within 2-3 years.