FUTURE GROUNDWATER MANAGEMENT ON MARS BY ARTESIAN WELLS, E.A. GRIN, NASA Ames Research Center, Space Science Division, MS 245-3, Moffett Field, CA 94035-1000.

The assessment of resources on Mars is one of the priority goals of future missions. Among potential resources, water is a requisite for future long-term activity on Mars. In the coming 10-15 years, teleoperated machines will be available to monitor the extraction of local resources. In unconfined aquifers, water needs to be pumped in wells, but water from flowing artesian wells flows freely. A well tapping a confined underpressure aquifer at a lower location than the potentiometric surface at the hydraulic head will flow freely. Two terrestrial analogs illustrate the role that the Martian permafrost may play in the confinement of the aquifer and in the extraction of the groundwater and suggest the technics that could be utilized on Mars. In Happy Valley Creek (Fairbanks, Alaska *see* fig.1a), the fluvial sediment deposit is a water-rich confined aquifer below the silt aquitard. The aquitard crosses the base of the permafrost layer. As the base of the permafrost is above the water-rich bedrock, no water can be obtained by artesian well. In Dome Creek Valley (Fairbanks, Alaska *see* fig.1b), again no water can be extracted from the frozen fluvial deposit. But, as the bedrock groundwater is confined by the base of the permafrost, its hydraulic heads rise above the ground surface [1]. In this configuration, the water flows freely from wells bored down to the water-rich bedrock. Current knowledge of Martian conditions is that the remaining water is trapped under a frozen ground at an average depth of 1 km [2]. Under this impermeable frozen cover, the water is under hydrostatic pressure [3]. This frozen cover extends into the regolith beneath the fluvial sediment of valley floor, lakebeds, and basins. In deep Martian valleys, the topographically controlled confined aquifer develops a high hydraulic head above the valley bottom (fig.2). The aquifer depth was recently revised was observational data of fluidized ejecta craters, and by impact experiments. The results are: a) the fluidization of ejecta requires an abundant water content of the targeted material; b) the distribution of fresh fluidized ejecta craters suggest a recent aquifer depth in the range of hundreds meters to several kilometers [4]. The depth/diameter ratio for fresh ejecta craters gives indications about the depth at which the water-rich level will be found. For fresh ejecta craters ranging between 2 and 20 km, the depth of the water-rich level is comprised between 200 and 500 m [5]. This depth may be less important in deep Martian fluvial valleys because the difference between hydrostatic and lithostatic pressure is reduced. The hydrogeologic profile in such deep fluvial valleys may be recorded by high-water sensitive subsurface radar sounding. Such device has been already designed to map terrestrial underground water occurrence down to 2.5 km at 15 m resolution [6]. The exploitation of terrestrial confined aquifers in permafrost environment by flowing wells must be used to modelize future exploitation on Mars, as the closest analogs. The collected data should be used to design flowing well equipment suitable for Martian environment. In the perspective of the management of Martian groundwater, a priority preliminary task must be to generate hydrogeologic profiles of the Martian subsurface by sending automated sounding equipment. A next step should be to perform field tests for teleoperated drilling devices using compressed Martian atmosphere [7]. The most favorable locations to perform tapping of underground water by flowing wells are deep valleys nearby volcanic constructs to benefit from the hydraulic head and geothermal flux.

References: [1] Freeze, R.A., and J.A. Cherry (1979) *Groundwater*, Prentice Hall Eds.; [2] Clifford, S. (1991) *Geophys. Res. Let.* , 2055-2058; [3] Tanaka, K. (1991) *J.G.R* 98, 15617-15633; [4] Boyce *et al.*, (1996) DPS 28th (abstract), 1059; [5] Jankosky, D. and Squyres, S. (1993) *Icarus* 100, 26-39. [6] Achache *et al.*, (1994) DPS 26th (abstract), 30-32; [7] Grin, E.A. (1996) (*submitted to ISRU)*.

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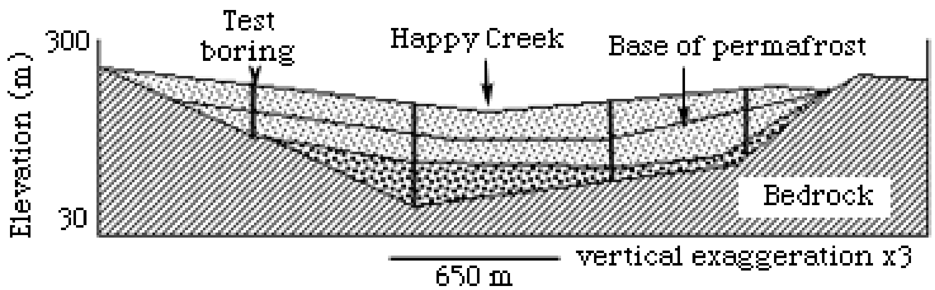
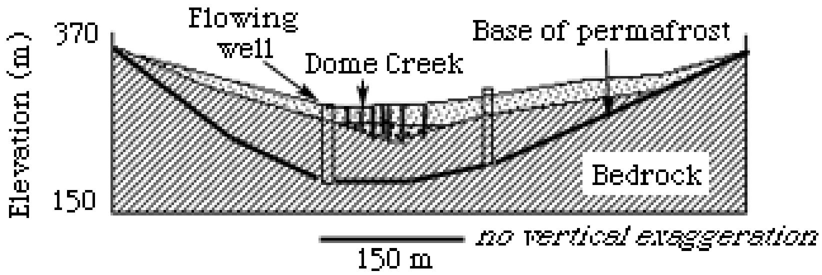
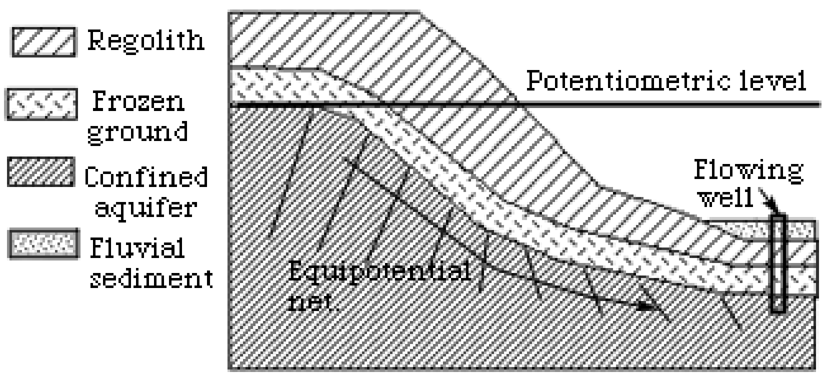


(1a)



(1b)

(Figs. 1a and 1b adapted after Freeze and Cherry, 1979)



(2)

Topographically controlled flowing artesian well in a deep Martian valley (after Grin, E.A., 1996)