COMPLEX EVOLUTION OF PALEOLACUSTRINE SYSTEMS ON MARS: AN EXAMPLE FROM THE HOLDEN CRATER. M. Pondrelli[1], A. Baliva[1], S. Di Lorenzo[1], L. Marinangeli[1] and A. P. Rossi[1], [1]International Research School of Planetary Sciences, Università d'Annunzio, Viale Pindaro 42, 65127 Pescara, Italy, monica@irsps.unich.it.

Introduction: Lacustrine systems are extremely sensitive to environmental fluctuations and, thus, they represent an ideal geological setting to investigate for climatic changes. Among the putative Martian paleolakes, the Holden crater (26S/326E) (Fig. 1) shows a richness of fluvio-lacustrine features. The Holden crater is 130 km wide and lies on Noachian rocks of the southern-cratered terrains [1]. The crater appears to interrupt a fluvial system of Hesperian age [1] which likely connected the Argyre basin to the northern chaos-outflow channels system. The main valley, Uzboi Vallis, cuts the southern rim and debouches into the crater. The Uzboi Vallis and Holden crater floors have been previously mapped as same units of fluvio-lacustrine deposits origin reworked by wind activity [2]. These deposits show a variety of sedimentary and morphological differences at MOC and THEMIS scale.

The aim of this work is to: a) recognize the sedimentary sequence and morphologies originated by fluvio-lacustrine processes; b) reconstruct the evolution of the depositional systems through time.

Geological units description: We performed a geological-geomorphologic mapping (Fig. 1) of the Holden area using MOC and THEMIS images and MOLA altimetry. The data processing and 3D representations have been produced through a planetary GIS system (MEGIS) created at IRSPS funded by the Italian Space Agency [3]. Geomorphologic features have been recognized and mapped in order to distinguish the surface modifying processes active through time. A particular attention has been devoted to identification of fan-like features, trying to differentiate alluvial fan, formed in dry lakes, and delta-fan formed in water-filled basin.

Layered Units: We have mapped and studied in detail the extension of stratified units found within the crater in order to understand their origin. Well-stratified deposits observed on MOC images have been previously interpreted as sedimentary rocks [1]. Close to the southern rim of Holden crater, alternating bright and dark deposits [1] crop out. The bright deposits consist of layered units with prevalent bright layers interlayered with dark strata often organized in a cyclic sequence (Fig. 2). We informally call this unit Sed_1 unit. Where possible, the thickness of cycles inside Sed_1 has been calculated, resulting in a 5 to 8 m stratigraphic interval per cycle. Dark deposits cover the Sed_1 unit (Fig. 2). We informally call this rocks Sed_2 unit. Layering is less evident, but still present at places. Sed_1 unit characteristics are consistent with deposition by means of water-related surface modifying processes. The unconformity at the top of Sed_1 unit suggests an erosion episode possibly due to emersion. In such phases, the lake could have been dry, resembling a playa. Wind driven processes became prevalent with the deposition of Sed_2 unit. Evaporite deposition could be possibly important for Sed_2. Alternating Sed_1 and Sed_2 unit and cyclic organization of the Sed_1 unit as well, confirm a change in the dominating surface modifying processes.

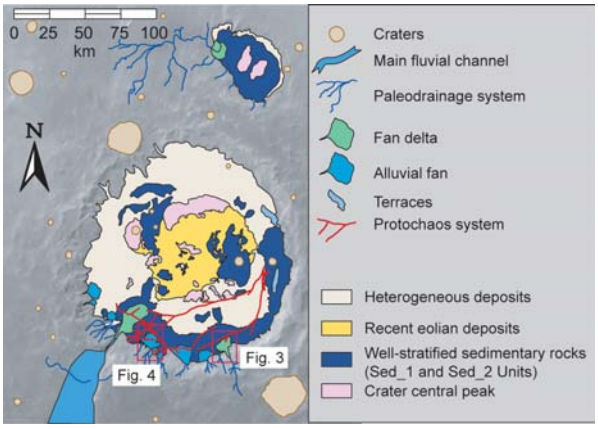

Fig.1 Geological sketch map.

Heterogeneous deposits: mass-wasting mantling layered deposits, which could possibly represent lateral equivalent of Sed_1 and Sed_2 units.

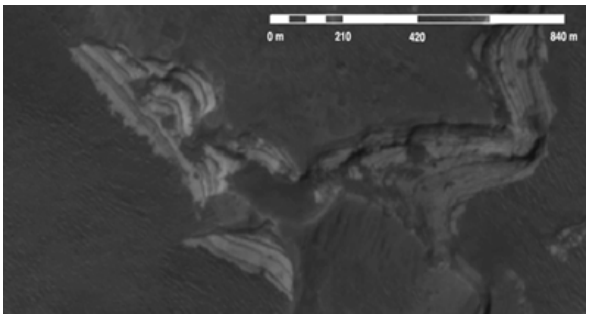

Fig. 2 - MOC image M2302006. Layered deposits of the Sed_1 unit displaying a cyclic depositional pattern. The Sed_2 unit unconformably covers this unit.

Recent eolian cover: Large barcane dune fields and unconsolidated sediment accumulation characterize the central part of the basin. The dunes cover older layered

rock formation and may be still active. Again, these layered deposits could represent lateral transition to Sed_1 and Sed_2.

Protochaos formation: Close to the southern rim, a chaotic system has been interpreted in the earliest phases of its evolution (Fig. 1). This may be related to the definitive dry up of the basin.

Fan-like features. Well-developed valley networks in the southern crater wall debouche into the crater, forming fan shaped structures.

The largest fan is located where Uzboi Vallis debouche into the crater. Some of the sub-environments related to the deltaic system can be recognized from the depositional architecture of the sedimentary bodies. Delta-top outcrops show a distinctive sub-horizontal stratification, consisting of Sed_1 unit deposits. Mouth bars display a coarser grained and less sorted texture. Contacts between bar deposits show angular unconformity with younger eolian sediments, which cover the distal portion of the delta system. In the topographic profile shown in Fig. 3, an elevation drop between a proximal low dipping and a distal part of the fan can be distinguished. This morphological feature originates when fluvial-dominated processes begin to interact with wave-dominated processes linked to the presence of a standing body of water. Another topographic step can be observed toward the basin center (Fig. 3). This feature suggests a multi-phase evolution of this fan. During the oldest phase, the fan delta probably extended into the crater and later, following a drop of the water level, the fan retreated towards the crater wall.

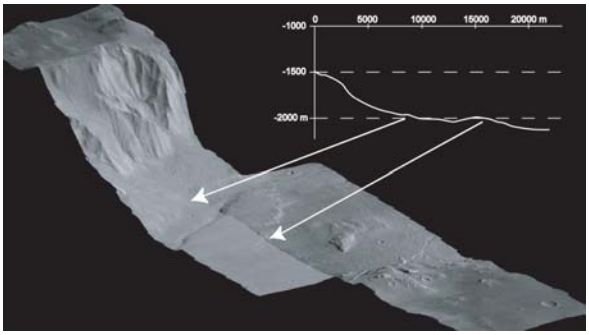

Fig. 3 - 3D representation of a multiple stage developing fan delta. (THEMIS V01375003–V02461004 draped on MOLA data)

In the example shown in Fig. 4 the topographic profile displays a constant dip of the fan, suggesting that was not formed under water. We interpret this fan as an alluvial fan depositing sediments in a dry lake. This setting is typical, on Earth, of both warm and cold arid environments.

In addition, terraces may be observed on the western side of the rim. Nevertheless, due to the large detrital cover, their geometry cannot be clearly constrained.

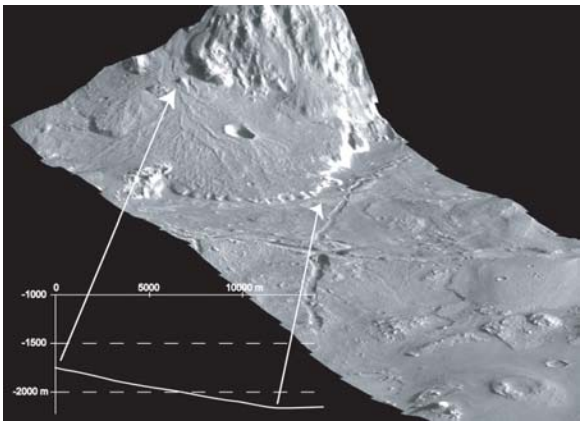

Fig. 4 - 3D representation of an alluvial fan. (THEMIS V03210003 image draped on MOLA data)

Evolution of the Holden lacustrine system: Many evidence for water-driven processes have been recognized in the Holden Crater, confirming that a standing body of water occupied vast areas inside it. The large Uzboi Vallis fan-delta and other several alluvial fans and fan-deltas have been documented along the border of the crater. Layered sediments were deposited during the fan deltas formation. The heterogeneous deposits may represent lacustrine deposit reworked by mass wasting and possibly wind driven processes. The most recent processes active are barcane dunes formation in the central portion and the beginning of a chaos-like structure along the southern border.

Fan features and the stratigraphic sequence suggest a complex evolution of the paleolake, characterized by fluctuation of the water level and active for long time. The changes in the sedimentary records reflect changes in the sedimentary processes possibly related to climatic variations.

Due to the richness of features related to aqueous environments, the Holden crater may represent a good target for future exobiological exploration of Mars.

References: [1]Scott D. H. and Tanaka K. L. (1986) *U.S.G.S. Misc. Inv. Series*, Map I-1802-A. [2]Saunders R. S. (1979) *U.S.G.S. Misc. Inv. Series*, Map I-1144. [3] Ori et al. (2004), *LPS*, *XXXV*, submitted. [4]Malin M. C. and Edgett K. S. (2000) *Science, 290,* 1927–1937.