ANCIENT CALDERA COMPLEXES IN ARABIA TERRA, MARS. Y. Y. Y. Chu[1,2], J. R. Michalski[1,2], and A. A. G. Webb[1,2] , [1]Division of Earth and Planetary Science, University of Hong Kong, Hong Kong, China (yycyoyo@connect.hku.hk), [2]Laboratory for Space Research, University of Hong Kong, Hong Kong, China.

Introduction: Arabia terra is an extremely ancient terrain, in the northern part of the Martian highlands, where the crust is anomalously thin. It is possible that the crust has been thinned due to denudation by erosion [1] and structural extension [2-4]. Which deep-seated discontinuities caused by regional extension could promote rapid ascent of magma, and hence facilitating explosive eruptions of primitive mafic magma.

The terrain also contains ancient, deep, steep-sided depressions that likely represent Noachian or Early Hesperian calderas [5]. In recent works [6-7], we performed geological and structural analyses of a few key volcanic complexes: Eden Patera (33.5°N, 348.8°E), type-locality of the plains-style caldera complexes; Siloe Patera (35.3°N, 6.55°E), which presents two overlapping classic piston-type caldera collapse; and Hiddekel Cavus (29.4°N, 16.2°E), a narrow, cone-shaped depression with extremely high depth/diameter ratio.

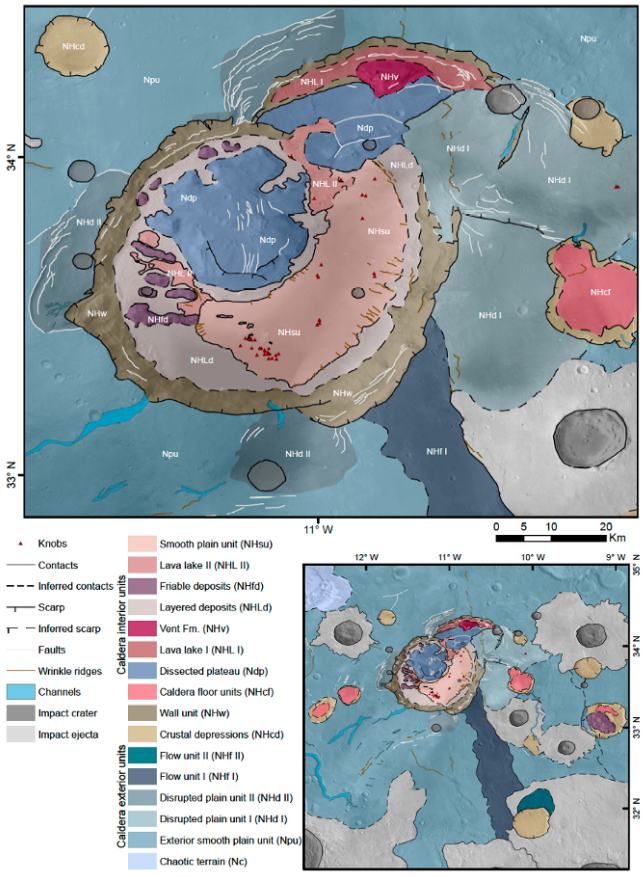

Figure 1: Eden Patera

Other aspects of the region that align with the hypothesis of ancient volcanic complexes, include vast fine-grained friable deposits of potential pyroclastic materials across Arabia Terra [8-11] and crustal remnant magnetic anomaly that shows local demagnetisation at the proposed caldera complexes [12].

Geomorphological and geological mapping: We have carried out remote sensing- based mapping of landforms, surface textures and contact relationships among surface units in order stratigraphic relationships, timing, and geological history of the several putative plains-style volcano complexes. Mapping results for Eden Patera, the type-example of such structures is shown in Fig. 1.

Fault-bounded relationship of the overlapping calderas and young caldera floor of Siloe Patera: Evidence for a volcanic origin of Siloe Patera were identified in previous work [6], including the relay ramp structure and a breached relay ramp along the northeast rim of the inner basin (Fig. 2), which indicated that the nested inner basin was formed by catastrophic failure. Another piece of evidence for a volcanic history of Siloe Patera is a suite of linear fractures with interlinking leveed pits (Fig.3), which could be evidence for potential fissure-controlled volcanism on the young caldera floor (<1 Ga from crater counting) of the inner basin.

Multiple phases of caldera collapse at Eden Patera: Various volcanic features at Eden Patera were identified, including a volcanic edifice, lava lake features and potential pyroclastic deposits (Fig. 4) [7]. Besides geomorphic features, evidence for a volcanic origin of Eden Patera from structural analysis were also presented [7]. Crustal collapse regions and external sagging of the surrounding Noachian plains were associated with at least four groups of arcuate faults and graben systems. Distribution and orientation of deformation features correlated the deformed crust, as well as differences in magnitude of displacement and crosscutting relationships of major arcuate faults, have suggested multiple phases of crustal collapse at the Eden Patera (Fig. 5). Thus, likely to reflect a complicated history of magmatic activity at the Eden Patera caldera complex.

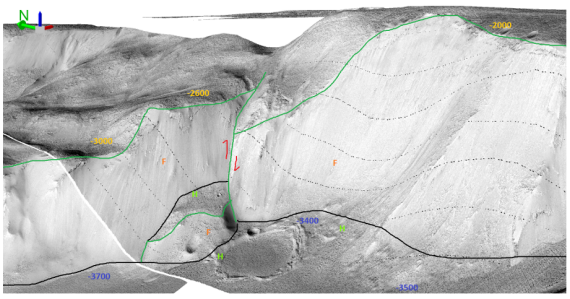

Figure 2: Relay ramp structure and the breached relay ramp feature at Siloe Patera.

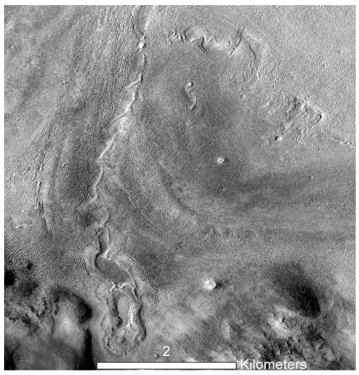

Figure 3: A series of N-S trending *en echelon* leveed pits on the inner basin floor at Siloe Patera.

Ancient caldera complexes in Arabia Terra: The three sites investigated in the studies share some key characteristics: 1) low topographic profile and lack of central edifice, 2) surface collapse, 3) multiple structurally linked depressions, 4) association with volcanic deposits including lavas and weakly consolidated layered deposits, and 5) association with local disrupted crust, sagging and faulting. They all presented evidence for caldera collapse and/or volcanic eruption, yet the origin of these depressions is still controversial partially because of their degraded surface. And plains-style caldera complexes could perhaps represent a large, underexplored, and underestimated form of volcanism during Noachian and Hesperian Epochs.

Data Availability: Data presented in this abstract and used in this project includes global datasets THEMIS and MOLA, obtained from the United States Geological Survey (USGS) [13-14]. High resolution imagery from CTX [15-16] and HiRISE [17] were used to map the regions and integrated global topographic dataset [18] of MOLA and HRSC [19] were used for geomorphological and structural analysis.

References: [1] Hynek B. M. and Phillips R. J. (2001) *Geology (Boulder),* 29(5); [2] Anguita F. et al. (1998) *Earth, moon, and planets,* 77(1); [3] Sleep N. H. (1994) *JGR*, 99(E3); [4] McGill G. E. (2000) *JGR*, 105(E3); [5] Michalski J. R. and Bleacher J. E. (2013) *Nature*, 502; [6] Chu Y. Y. Y. et al. (2021) *GRL*, 48; [7] Chu Y. Y. Y. et al. (2023) *JGR Planets,* e2022JE-007337; [8] Kerber L. et al. (2012) *Icarus,* 219; [9] Grant J. A. and Schultz P. H. (1990) *Icarus,* 84; [10] Malin M. C. and Edgett K. S. (2000) *Science,* 290; [11] Fergason R. L., and Christensen P. R. (2008) *JGR*, 113(E12); [12] Morschhauser A. et al. (2014) *JGR Planets*, 119; [13] Edwards C. S. et al. (2011) *JGR Planets*, 116(E10); [14] Smith D. E. et al. (2001) *JGR* 106(E10); [15] NASA/JPL/MSSS/The Murray Lab (2018); [16] Malin M. C. (2007) *NASA Planetary Data System*; [17] McEwen A. S. (2006) *NASA Planetary Data System*; [18] Fergason R. L. et al. (2018) USGS Astrogeology Science Center; [19] Neukum G. and Jaumann R. (2004) *Mars Express : The Scientific Payload*, ISBN 92-9092-556-6.

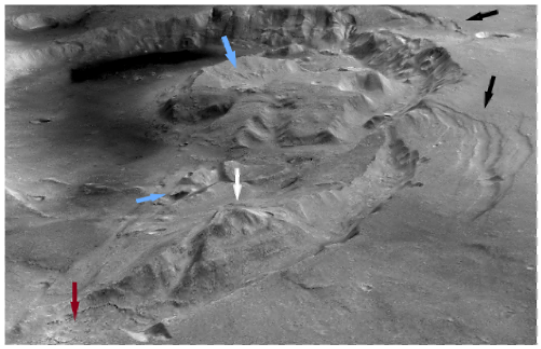

Figure 4: 3D-view generated on ArcScene with CTX and HRSC data, showing perspective from the northeast with four times topographic exaggeration showing volcanic edifice (white arrows), broken crustal blocks (blue), lava lake features (red) and concentric faults (black).

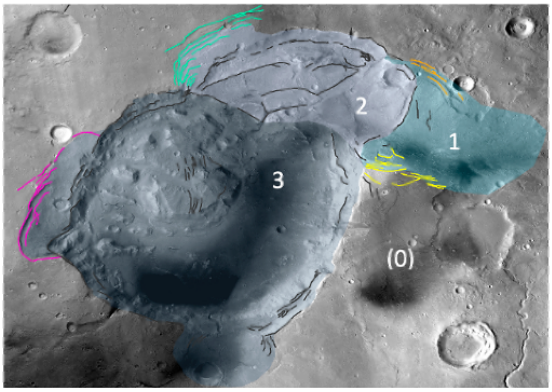

Figure 5: Multiple stages of crustal collapse at Eden Patera.