MARS COLOR CAMERA ONBOARD MARS ORBITER MISSION: INITIAL OBSERVATIONS & RESULTS. A.S. Arya*, R.P. Rajasekhar, Rimjhim B Singh, Koyel Sur, Prakash Chauhan, S.S. Sarkar, S.Manthira Moorthi, A. R. Srinivas, Vishnu Patel, Sampa Roy, Indranil Misra, Rajdeep Kaur Gambhir, Kamlesh K Patel, D.R.M. Samudraiah, A.S. Kiran Kumar, Space Applications Centre, Indian Space Research Organization, Ahmedabad, India, ***arya_as@ sac.isro.gov.in**

The Mission & its uniqueness: Mars Orbiter Mission (MOM), the inter-planetary mission of Indian Space Research Organisation (ISRO) to the planet Mars, launched on November 5, 2013 is a maiden & unique Indian attempt towards sending orbiters to other planets in our solar system. It is the most cost effective inter-planetary mission ever carried out globally**,** accomplished in record time and inserted in the Mars orbit in its first attempt itself. The mission has a unique and highly elliptical Martian orbit of about 261 km (Periareion) to 78,000 km (Apoareion). Among contemporary, MOM is also credited with some more laurels like miniaturisation of five heterogeneous science payloads and minimal path corrections during entire cruise phase.

The Payload: Mars Color Camera (MCC) is among the five science payloads onboard Mars Orbiter Mission. It operates in visible range (0.4 to 0.7 µm) and uses RGB bayer pattern[1]. Its IGFOV varies from about 15 m to 4 km. The detector array has 2048x2048 elements on a pixel pitch of 5.5µ. The sensor is driven by a custom built electronics designed around the detector [2].

Scientific Objectives: MCC has been designed to meet the following major objectives: -
1) To image the surface features of Mars with varying resolution and scales from highly elliptical orbit. 2) To map the geological setting of area around Methane sources that will be picked up by MSM (Methane Sensor for Mars) onboard MOM. 3) To monitor dynamic behaviour of the dust `devils' or dust-storms, cloud patterns etc. 4) Imaging of Phobos/Deimos. 5) To provide contextual Information for other non-imaging science payloads onboard MOM, mostly operating in non-visible range of electromagnetic spectrum.

Initial results: After Mars orbit insertion, MCC has returned about 250 spectacular images of Mars in about 3 months, including images of its two Moons and close encounter with comet siding spring (October19, 2014). Some of the initial observations / results are presented herewith, as under.

The single-shot images of full Mars disc are an asset to view and monitor the dynamic processes, active at regional to global scale on Mars. The varying cloud pattern, crowning the top of northern hemisphere and the movement of the dust storm in southern hemisphere could be clearly seen in the following two images separated by a week's time i.e between 30th Sept & 7th Oct, 2014 (Fig. 1)

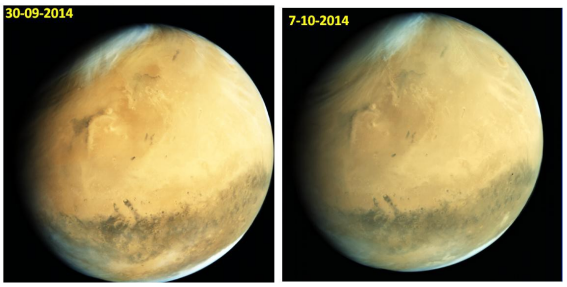

Fig. 1: Multi-temporal variation of cloud and dust pattern on Martian hemisphere separated by a week's time

Similarly, activity of a major `dust devil' could be seen prograding between Oct 20 & Oct 28, 2014 in northern and equatorial region. The dust front is seen spreading eastward along Acidalia to central Noachies, to the Hellas, then swirling westward near Argyre and ultimately fading out along Vallies Marineris. (Fig. 2)

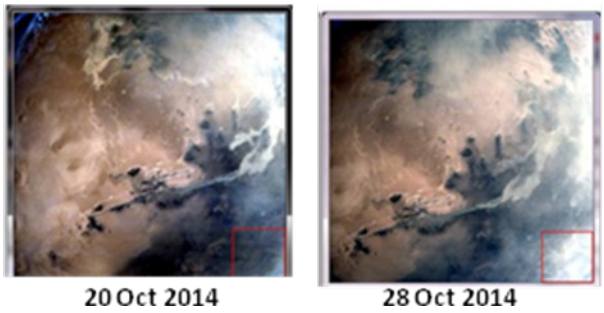

Fig. 2: Major dust devil seen spreading in a week's time

This information helps in interpretation of the data from other sensors onboard MOM, like Methane Sensor for Mars (MSM), by carrying out atmospheric corrections using appropriate models.

Another interesting study was carried out around 50 degrees northern latitude. There was a lofty isolated patch of cloud extending a clear shadow on Martian surface. The sun-elevation angle and the magnitude of shadow displacement were used to determine the

cloud height that was estimated to be between 35-38 km, which is the abode of carbon-dioxide ice clouds (Fig. 3). It is worth mentioning that unlike Earth, there are two types of clouds in Martian atmosphere viz. water-ice clouds and CO_2 ice clouds. The later occurs mostly 20-25 km above the Mars surface. Differentiating them visually is otherwise a challenging task and hence this technique.

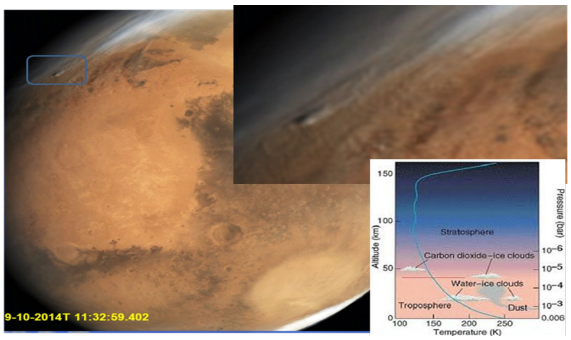

Fig. 3: Detection of CO_2 ice cloud

Besides, imaging the Martian surface, MCC has also captured Phobos, one of the natural satellites of the Mars in motion, on Oct 14, 2014 between 11:25:35 and 11:26:10 UT. The spatial resolution is about 550m. Phobos is seen moving from dark-space background into the Martian backdrop during the imaging period (Fig. 4).

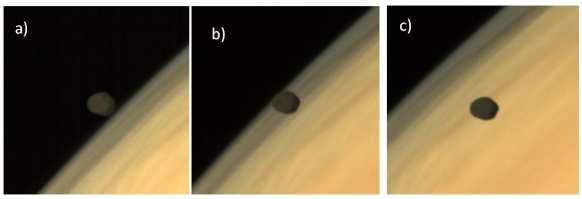

Fig. 4: Phobos captured during its revolution around Mars

Similarly, the other natural satellite of the Moon i.e. the Deimos was also captured on the same date at 13:06:11 UT (Fig. 5). The spatial resolution is 300 m.

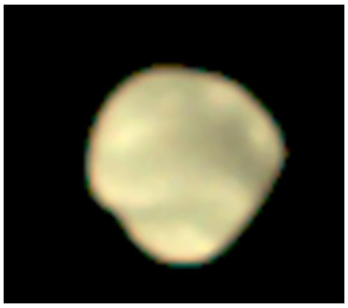

Fig. 5: Deimos imaged in the Martian orbit

One of the most important task of MCC is to furnish contextual information for other sensors onboard, especially which are either non-imaging or operate in other than visible electromagnetic spectrum. The image below (Fig. 6) shows the track of MSM (yellow stripes) laid over the corresponding mosaic of MCC images, acquired simultaneously, thus helping the MSM to orient and facilitate its meaningful interpretation.

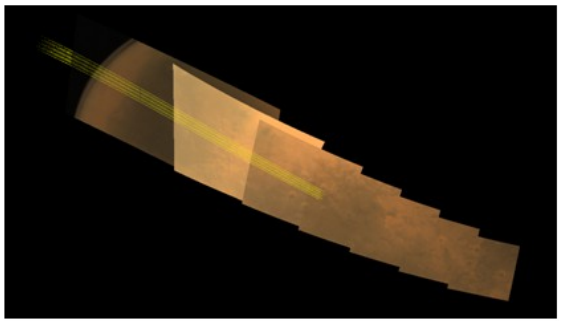

Fig. 6: Track of MSM (yellow stripes) overlaid on the mosaic of polygonal MCC images for contextual information.

It may be concluded that the Mars Colour Camera has performed as expected and returned high quality and meaningful images which have been used for monitoring the dust/ cloud conditions in single-shot for entire disc of Mars. It could be used to differentiate the CO_2 Ice-cloud from the rest. MCC has also captured the two Moons of the Mars, besides returning amazing pictures of close encounter with comet C/2013 A1 (Siding Spring). MCC has been successfully catering to the contextual requirement of other co-sensors onboard MOM. In totality, MCC has met most of its desired objectives so far, and will continue to return meaningful images with higher resolution in future as the sun moves towards periareion.

References: [1] Arya A.S. et.al (2014), *LPS XXXXV,* Abstract# 2449. [2] Mars Color Camera team (2013), Pre-shipment review (PSR) document of Mars Color Camera of Mars Orbiter Mission, Sensor Development Area, Space Applications Centre (SAC-MOM-04-April 13).