Water on Mars: new findings

In 2015 September NASA announced the finding of what seem to be small amounts of liquid water, just below the surface of the planet. Basically, the water appears to be associated with the seasonal appearance of dark streaks on crater walls or other steeply sloping terrain. These 'Recurring Slope Lineae', or RSL, appear when seasonal warming takes place, and then fade as the planet's surface cools later.

The temperature measured for the dark streaks is below the freezing point of pure water, but would not be too cold for saturated solutions of some inorganic salts. (Recall that common salt, sodium chloride, lowers the freezing point of pure water by reducing the vapour pressure, hence its use to prevent ice forming on roads.) Investigators used spectroscopic data from the *Mars Reconnaissance Rover* to look at four selected sites where RSL are found: three craters including the large *Hale* crater (lat. –36°, long. 36°), and also *Coprates Chasma* (–11 to –14°, 54 to 68°). In each case signatures of hydrated salts were seen (though not liquid water as such). The suggestion is that the salt-laden water flows just below the surface, when the temperature exceeds –20°C, and in so doing generates Lineae which grow up to several hundred metres in length. It is thought that the water dissolves the salts on its way to the surface, and then deposits them through evaporation.

As the presence of subsurface ice for melting at near-equatorial sites such as *Coprates Chasma* is not very likely, it is possible that the water is absorbed by the salts directly from the atmosphere. The deposited salts lower the surface reflectivity.

Pure water cannot exist at the extremely low surface pressure found on the planet: it is only stable as ice or water vapour. However, the spectroscopic data point to the presence of chlorates and perchlorates (containing the ClO_3^- [chlorate (V)] and ClO_4^- [chlorate (VII)] ions, respectively). Such salts (when their cations come from Groups I and II of the Periodic Table: such as Na^+, Mg^{2+} and Ca^{2+}) are very soluble in water, and data from the NASA *Phoenix* lander and the rovers support their presence in other locations. (See C. M. Carlisle, *Sky & Telescope*, **131**(1), 14 (2016 January), and *The Times*, 2015 September 29, pages 1–3 and 29.)

Of course, no-one seriously expected to find life upon the martian surface, irradiated as it is by high frequency ultraviolet light from the Sun, and the presence of highly oxidising perchlorates would be a further obstacle to the existence of living organisms there. However, the identification of any form of liquid water, even in the form of a saturated inorganic salt solution, adds to the ongoing interest in the Red Planet and fuels speculation about the origin of the seasonal release of methane from specific surface sites, and the possible implications which that may have for the existence of micro-organisms in the interior.

The opposition of Mars, 2016: 1st interim report

The 2016 opposition of Mars will occur on May 22. The planet will be closer to the Earth than it was in 2014, but its altitude for northern hemisphere observers will be still lower than before. The declination at opposition in fact will equal –21° 40', so that the meridian altitude for a typical UK latitude of 52°N will only be about 16°.

At the time of writing (2015 mid-December) the N. polar cap has shrunk considerably to its near-minimum diameter during the N. hemisphere late spring, but by the time of opposition in 2016 the season will already have advanced past midsummer in the N. hemisphere, and hence it will be winter in the south. The planet will then be starting to exhibit a large S. polar cap, though the date at which the SPC is revealed beneath the seasonal hood does vary a little from year to year. The S. polar cap will be turned slightly away from us until after opposition: later work will reveal its sublimation.

The planet's albedo markings to date are looking closely similar to their appearance in 2014–'15, and as we noted in a recent Council Report (R. J. McKim, *J. Brit. Astron. Assoc.*, **125**(5), 295 (2015)) there was no sign, at least from our ground-based observations, of any planet-encircling dust storm during the appropriate seasons at the end of the last apparition. Thus there is no reason to expect to be able to see large albedo changes upon the surface as the planet returns to prominence in the morning sky.

The seasonally earliest-ever planet-encircling storm (which occurred in 2001) arose at aerocentric* longitude (Ls)= 185°, and as Ls will read 156° at this opposition, the dust storm season will then be approaching, and so it is possible we may see some activity somewhat after opposition in 2016. The usual emergence sites for major storms are located in the S. hemisphere: *Hellas*, *Noachis*, *Argyre* and the areas around *Solis Lacus* (*Solis Planum*), but *Libya–Isidis Regio* should also be watched, as activity was seen to arise there in 2014 for the first time in some years, and historically this site has also generated major storms. The brightness of a region in orange or red light is a good guide to atmospheric dust activity being present.

Images from 2015 September–December have

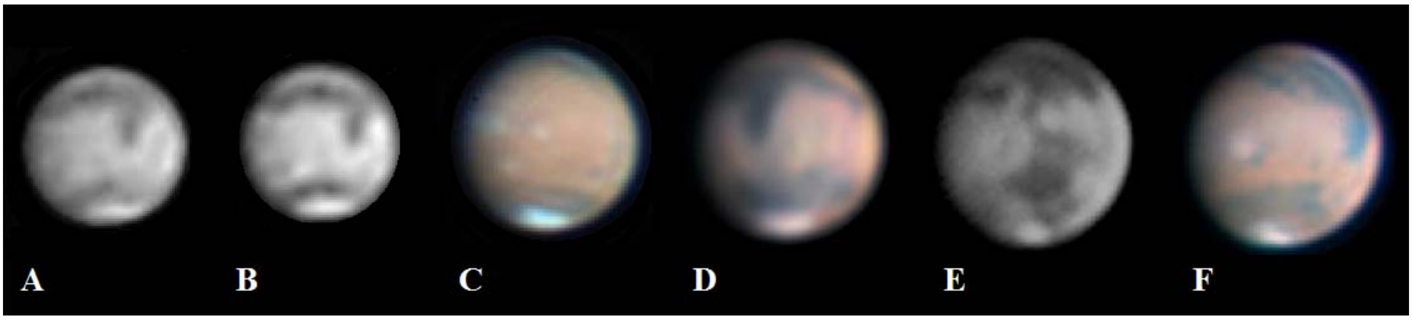

Figure 1. Early images of the 2015–'16 apparition taken during the planet's mid- to late northern spring, Ls= 040–080°, by P. W. Maxson (315mm Dall–Kirkham, ASI224C camera), C. Foster (355mm SCT, ASI224MC camera), E. R. Morales (305mm SCT, Flea3 camera) and T. Olivetti (410mm Dall–Kirkham, PG Blackfly ICX692 camera). All images have south uppermost.

A. 2015 Sep 11d 13:29 UT, CM= 270°, disk diameter (D)= 3.8", 685nm filter, *Maxson*. **A** and **B** both show the normal aspect of the *Syrtis Major* hemisphere, with *Nepenthes* remaining invisible after several decades.

B. 2015 Sep 12d 13:29 UT, CM= 260°, D= 3.8", 742nm filter, *Maxson*.

C. 2015 Oct 14d 22:42 UT, CM= 139°, D= 4.0", RGB image, *Olivetti*. Despite the tiny disk size, several orographic clouds are well visible over the martian volcanoes as well as a southward protrusion from the diminishing N. polar cap.

D. 2015 Nov 15d 10:00 UT, CM= 304°, D= 4.5", *Morales*.

E. 2015 Dec 5d 03:21 UT, CM= 012°, D= 4.8", *Foster*. The *Indus* 'canal' running from SE *Niliacus Lacus* and *Oxia Palus* is the result of sharpening of the tiny image. The *Mare Acidalium* hemisphere presented otherwise looks normal.

F. 2015 Dec 12d 22:50 UT, CM= 238°, D= 5.0", *Olivetti*. The seasonal separation of *Olympia* from the N. polar cap is obvious on the *p.* side of the planet. We can also see a hint of the *Syrtis Major* blue cloud on the following side, and a bright evening orographic cloud over *Elysium Mons*.

* Richard: I was unsure, but should this read "areocentric"?

already begun to reveal many small markings. Some examples of these images are reproduced in Figure 1. Note that the disk diameter did not exceed 5 arcseconds for the entire period!

In terms of comparisons with previous apparitions, satisfactory matches occur at intervals of 15, 32 or 47 years apart, so 1969 will be very suitable, when opposition occurred on May 31 with Ls= 166°. As in that apparition (see E. H. Collinson, *J. Brit. Astron. Assoc.*, **81**(1), 49–54 (1970)) plenty of detail can occasionally be seen even when the planet's altitude is quite low: patience is required, and an orange or red filter or a narrow-angle prism can help to suppress atmospheric dispersion. In 1969 there were no electronic images available, just rather grainy photographs, and at that epoch it would have been exceptional to have followed the planet with a disk diameter below 6". We could also make an equally good comparison with 1984 (Ls= 146° at opposition), and a reasonable comparison with 2001 (Ls= 177°): see our website at **www.britastro.org/mars** for downloadable past reports and observational aids.

As ever I shall be very glad to receive members' observations regularly, and to publish more interim reports during the year, as the developing events upon the planet may dictate.

Richard McKim, *Director*