Reflections

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In this issue

President's Message

Hello all Members and Prospective Members,

The first thing I would like to say is how delightful it was to join with so many at the annual BBQ at the College recently.
Hard to say exactly how many attended but the count was between 45 and 48 members, partners, old friends and guests.
Given there were a few hard core members who were not able to attend, the rollup was strong and we would clearly have topped fifty otherwise.
All enjoyed the conversation, the lunch and a few drinks.
Thanks to all who attended and particularly the helpers who jumped in to assist with all the prior purchasing, the cooking, setup, cleanup, two-up, and all the preparation needed to serve so many people.
And then there was the solar observation going non stop. There was so much going on that surprise guests Brian Cox and Stephen Hawking finally had to leave without presenting.

With the members saying in the survey early this year that these social events were important, we should look further at a second gathering. Yes, that's right, we read the survey and took note of the results!

Coming up in October is the usual monthly General Meeting (a short one) and the Annual General Meeting.
We have quite a few new members this year (and last year) and hopefully you will come along and see how NSAS operates in the engine room.
And hopefully also you will put your hand up to help out.
We operate on a share-the-load basis and look for help from all the membership

These last two years we have moulded ourselves into an efficient, more sustainable unit where responsibility is shared, rather than relying on the superhuman efforts of one or two people.
There are places in our management structure for people of all technical and skills levels. I for one am not at all technical.
So I appeal to all members, old and new, to step forward. One obvious way is to join the Committee as a "without portfolio" member, learn how the place operates and contribute when you are ready and able.
You will not be pressured, and there are vacancies.
And a couple of ladies would be welcome as well, that might add some additional colour and spirit.

Our subgroups have been travelling well; some with ups and downs but core activities such as Outreach and Observations remain strong.
This year's NAG has attracted and maintained keen interest and has become the main and ongoing source of our new members.

Solar observations are also enjoying strong interest and support.
Otherwise, in the "coming-up" department, don't forget the Christmas Party, to be held as usual in lieu of a December Meeting. Drinks supplied; please bring a plate and your best conversation.
New members, old members, families and friends, come along in force and build on the success of the BBQ.

Watch out for the Linden field trip; Gordon has been working hard on getting the first one up and running and it will come together soon.
The weather has been unkind and there were some communication hiccups, but we're in there.
And also in the field trip mode, we are now beginning to look more closely at the summer visit we have mentioned, probably to Jindabyne, with a stop-off at Canberra.

See you at the AGM. Please.

Bruce Retallick
President

(OK, the two-up was a joke. But Brian and Stephen really were there. Really...)

Yes, we've made it!
We've been able to deliver each and every quarterly issue for this year.
But... with a capital B, this is only thanks to its new and more flexible electronic format that has allowed us to produce 4-page issues instead of the usual eight pages.

I know, you are mindful not to overload this editor with an excess of contributions but wouldn't it be nice if , next year, we could ramp up the number of pages to five, six and maybe get back to eight?
Ok, that's a bit of day-dreaming but think about it: our society has more than a hundred members and only 4 of them have contributed to this year issues.
I believe we can do better.

Anyway, enough whingeing and on to a more positive subject: the winners for this year Geoff Welch Prize have been chosen and will be presented with their prizes at the October 21st General Meeting, prior to the AGM.
Be there and congratulate our laureates.

Cheerio,

Jean-Luc Gaubicher

Calendar

General Meetings:	October 21st	Annual General Meeting
	November 18h	Speaker: Dr Andrew Sheinis (AAO) - The development of astronomical instrumentation.
	December 16th	Christmas Party
NAG Meetings:	Every fourth Tuesday of the month	
Observing Nights:	Consult NSAS' web site at http://nsas.org.au/observing/	
Deadline:	Please send your contributions to the January 2015 issue of Reflections in time to reach the editor **before December 15th** to nsas.editor@ozemail.com.au	

A few Meteorites are from Mars

Of over 61,000 meteorites found on Earth, a mere 132 have been identified as Martian in origin [1]. This article outlines the detective story of how that identification was achieved.

Stony meteorites account for some 94% of all meteorites found on Earth. Of these, over 90% are chondrites, so called because almost all are composed of small spherical particles (chondrules) that appear to have melted while freely floating in space prior to their incorporation in meteorites. Chondrites are typically about 4.55 billion years old (based on radiometric dating) and are thought to represent material from the asteroid belt. 4.55 billion years has been taken to represent the age of the Solar System and the time of formation of asteroids.

EETA 79001 aka Elephant Moraine 79001 as found in Antartica
Picture Credit: NASA

The other kind of stony meteorite, achondrites, is thought to have crystallised from a magma in the same way as terrestrial rocks. Among achondrites, a small number of igneous meteorites were identified by the 1980s as being anomalously young and having oxygen isotope compositions that differed from those of other meteorite groups. These anomalous meteorites were collectively called SNC meteorites. This name was based on the meteorites' classification into 3 types, each named after a type specimen:

- Shergottites, named after the Shergotty meteorite that landed in the Indian village of Shergotty in 1865 (96)
- Nakhlites, named after the shower of meteorite stones that landed in the Egyptian village of El Nakhla el Baharia in 1911 (13)
- Chassignites, named after the shower of meteorite stones that fell on the French village of Chassigny in 1815 (2)

[The number of meteorites in each sub-group as at 9 January 2013 is shown in brackets; 3 of the total of 114 SNCs are unclassified.]

The nakhlites and chassignites have ages, based on radiometric dating, of around 1,300 Ma. Shergottites are even younger at about 165-200 Ma. As igneous rocks are generally formed by crystallisation of molten rock as it cools, the straight-forward explanation for these young ages is that they represent when the SNC rocks crystallised from a melt. But this rules out SNCs having a source in the asteroid belt since the necessary igneous activity would have occurred long after it had been assumed that the asteroids had cooled and solidified.

Suggestions that SNCs might have come from a planetary body like Mars initially faced the objection that no meteorites from the Moon had been discovered and an impact capable of ejecting a fragment of the lunar surface into an Earth-intersecting orbit was surely much more probable than such an event on Mars, given the Moon's lower escape velocity and close proximity to the Earth.

This objection fell away, however, with the unanimous acceptance that meteorite ALH A81005, found in the Allan Hills region of Antarctica in 1982, was of lunar origin.

Consensus was readily achieved because ALH A81005 was identical in mineralogy, mineral chemistry and isotopic composition to Apollo and Luna [2] samples brought back from the Moon to Earth.

EETA 79001
Picture Credit: NASA

The conventional view that the dynamics of cratering of planetary surfaces by asteroid impact was unfavourable to producing meteorites was thus overturned.

Since the crystallisation ages of SNCs lie between 165 and 1,300 Ma, SNCs have to originate from an astronomical body that featured molten rocks as recently as 165 Ma ago. The giant planets can therefore be eliminated because their exterior layers are predominantly gas and/or ice, not rock. The absence of blocks of ejecta when the comet Shoemaker-Levy/9 hit Jupiter reinforces this conclusion.

Comets and Kuiper Belt objects can be eliminated because they have never been molten. Thus, the source for SNCs narrows

down to the handful of rocky bodies in the Solar System: Mercury, Venus, Earth, Moon, Mars and the rocky moons of the giant planets.

ALH 84001
Picture Credit: NASA

The rocky moons of the giant planets can then be discounted because the immense gravitational attraction exerted by their parent planet would surely prevent the escape of any ejecta.

Mercury is discounted because any potential impactor would be much more likely to fall into the Sun than onto tiny Mercury and anyway any ejecta from Mercury's surface would surely be pulled towards the Sun rather than projected outwards with sufficient energy to reach Earth's orbit.

North West Africa 7034 aka Black Beauty
Picture Credit: NASA

Venus is not completely ruled out a priori. However, any incoming impactor would lose substantial energy and mass in penetrating Venus's thick atmosphere, as would any resulting ejecta from Venus's surface as they were projected outwards. In addition, Venus, having a mass comparable to Earth's, has a high escape velocity. The probability of ejecta attaining sufficient energy to intersect Earth's orbit is therefore considered highly remote.

Earth has lots of young igneous rocks and dynamically it is feasible for an impactor to have produced ejecta like SNCs. However, all oxygen-bearing rocks from Earth show a characteristic variation in the ratios of the 3 stable oxygen isotopes (^{16}O, ^{17}O, ^{18}O). SNCs fail to show this. This eliminates Earth as the parent.

The Moon is heavily cratered, close to Earth and has a modest escape velocity. However, the Apollo and Luna samples of lunar rocks are all older than SNCs and are mostly breccia fragments rather than the igneous cumulates [rocks formed by gravitational settling of particles in a magma] and basaltic flows required to match SNCs. As well, the composition of meteorites identified as coming from the Moon (ALH A81005 and later finds) is very different from SNCs. Most tellingly, the oxygen in lunar rocks shows the same isotopic trend as terrestrial rocks. SNC meteorites thus do not come from the Moon.

This leaves Mars by process of elimination. Additional evidence is considered to put the case for Mars beyond doubt:
The shergottite meteorite EET A79001, collected in 1979, was found in 1983 to contain small quantities of gas trapped within the inclusions of black glass scattered throughout its interior. The glass was formed by melting of mineral grains, presumably during the impact event that ejected the meteorite from its parent body's surface. The chemical and isotopic composition of this gas turned out to very closely resemble that of the Martian atmosphere as measured by NASA's Viking lander in 1976. Because of their common oxygen isotopic composition, all other SNCs must come from the same parent body as EET A79001 – this means Mars.

Argon is an excellent dating tool, being chemically inert and having 3 stable isotopes, ^{36}Ar, ^{38}Ar and ^{40}Ar, whose mix varies widely across the Universe. Bodies such as the Earth, Sun and Jupiter show a $^{36}Ar/^{38}Ar$ isotope ratio of 5.5, which is interpreted as the ratio for the primordial Solar System. Analyses of gas bubbles trapped inside SNCs, however, revealed a distinctively lower $^{36}Ar/^{38}Ar$ ratio of between 3.6 and 4.5. This was consistent with these SNCs having Martian origin, but not decisively so, since the Viking measurement for the Martian atmospheric ratio had a wide range of 4 to 7.
In October 2013, however, NASA announced that the Curiosity rover had made a high-precision count of the two argon isotopes, pinning down the Mars ratio to 4.2 and confirming the SNCs' Martian origin. The explanation for Mars' distinctively lower ratio is its weaker gravity: ^{36}Ar rises to the top of Mars' atmosphere and, being lighter, is more readily lost to space over time than ^{38}Ar.
While all meteorites with attributed Martian origin are igneous rocks, the different mineralogy and chemistry of the 3 kinds indicate formation in different locations.
Hence all SNCs do not come from a single ejection event. A current direction for research is to identify the specific regions on Mars from which SNCs have come. For example, the Mojave crater, 58 km in diameter and approximately 5 million years old, has been identified as the likely source of shergottite meteorites [3].

Ian McKenzie

Noteds

[1] Statistics as at 3 March 2014. Source: Meteoritical Bulletin Database UPDATE

[2] Three missions during the USSR's Luna space program, Luna 16 (1970), Luna 20 (1972) and Luna 24 (1976), robotically collected lunar soil samples and returned them to Earth.

[3] Werner, SC, Ody, A, Poulet, F, The Source Crater of Martian Shergottite Meteorites, Science, 343, 7 Mar 2014

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- *Billings, Lee, Solved: The Mystery of the Martian Meteorite, Scientific American, Jul 26 2013*
- *Grady, Monica M, The History of Research on Meteorites from Mars, in McCall, GJH, Bowden, AJ, Howarth, RJ, (eds) The History of Meteoritics and Key Meteorite Collections: Fireballs, Falls and Finds (2006) Geological Society, London, Special Publications, pp 405-416*
- *NASA, NASA Rover Confirms Mars Origin of Some Meteorites, media release, Oct 17 2013*
- *Wikipedia Martian Meteorite*
- *Wikipedia Meteorite*

Astronomy on an Active Volcano - Revisited

Some of you may remember an article "Astronomy on an Active Volcano" written by Bob Fuller and published in the April 2012 edition of Reflections. After having just returned from a trip to Hawaii, I thought I'd share my experiences there.

Hawai'i refers both to the US state and to the biggest island in the archipelago.
The capital, Honolulu on the island of O'ahu, is a 10-hour flight from Sydney. We stayed there for two days, in a hotel on Waikiki beach, before taking a short plane trip to the "Big Island". Waikiki has more tourists and shops then the Gold Coast, but less beach area/sand and smaller waves.

On the Big Island, we stayed at a resort in the small coastal town of Kona. Kona is on the dry side of the island, and is built on the slopes of the still very much active Hualalai volcano. This volcano last erupted 200 years ago, leaving some quite impressive lava flows on the outskirts of the town.

The native vegetation of the Big Island has been all but destroyed by introduced animals such as cattle, pigs and goats. We saw whole sides of mountains where there was not a tree left standing. No wonder the native Hawaiians are not overly impressed with "progress".
I don't know what the first Europeans thought would happen when they let their animals loose.

We joined a tour group to visit the telescopes on the summit of Mauna Kea. There are several companies that go there, but we went with Hawaii Forest and Trail (http://www.hawaii-forest.com/). They had a 4WD minivan, to cater for unpaved sections of road, and included dinner, warm jackets for the summit and an observing session down by the visitor centre.

I'm not sure how long ago Bob visited it, but Mauna Kea is now classified as a dormant volcano as it last erupted 4,600 years ago. The summit is over 13,800ft (4,200m) high and temperature can get below freezing during winter. The tour bus has an emergency oxygen bottle lest anyone could not handle the altitude. My mother who is 81 did not have any problems.

We did not get to see inside any of the telescopes. However, some of the telescopes had opened up their domes in preparation for the night's observation. We did get to see the setting sun over the various domes.

The observation cession was conducted in the car park of the visitor centre. The visitor centre is at a more respectable 9,200ft (2,800m), but still get a bit cold at night. Got to see the North Star (Polaris) for the first time.

For those people who are not that interested in astronomy, I would suggest they check out the volcano tours. The Kilauea volcano has been continuously erupting for 20 years and has created some quite impressive lava fields as well as multiple calderas. It is always a good idea to show Pele, the Hawaiian volcano goddess, a bit of respect.

Bob's article mentioned the difficult birth of the Thirty Meter Telescope (TMT). While we were there, it was announced that they had just received approval to start its construction.

David Wallace

Pictures by the Author

References:
http://en.wikipedia.org/wiki/Mauna_Kea
http://www.ifa.hawaii.edu/info/vis/
http://www.tmt.org/

Sun Parties

Pictures of the two Sun Parties held in the grounds of St Ignatius college in July and August as taken by Lydia Bell.