H.F.MADSEN & J.P.V.MADSEN: PIONEERS OF AUSTRALIAN SCIENCE-THE BEGINNING.

AUTHOR: Roger Madsen, Sydney, 2019.

PREFACE.

The information relating to H.F.Madsen's 18 inch reflector telescope was largely compiled in 1995 by the author & more recently the details of H.F.Madsen, J.P.V.Madsen & the Royal School of Mines describe the origins of pioneering scientific work in Australia by this father & son combination.

It appears that the influence of 2 prominent early Danish astronomers at Copenhagen University probably kindled an interest in astronomy in H.F. Madsen who was at the University briefly in 1861.

The ingenuity applied by H.F.Madsen in making a hand polished & silvered 18 inch specular produced a mirror described as "perfection" by experienced astronomers who knew of it. It may be that the sightings of the 2 moons of Mars in Sydney in 1892 using the Madsen telescope was the first time this had been achieved in the southern hemisphere, the first time being by Asaph Hall in the northern hemisphere at the U.S. Naval Observatory in Washington D.C in 1877, but there is no definite evidence that this is the case as there was opportunity to observe sightings at earlier dates but it seems would require a very good telescope.

The influence of the Royal School of Mines in London was felt in the formation of the Ballarat School of Mines in 1871 in the choice of subject matter to include elementary mathematics & surveying which it fortuitously for H. F. Madsen he proved to be good at & led to his being offered a position as surveyors assistant with John Philips the erstwhile master of the fledgling BSM.

The influence of the Royal School of Mines was also felt by Archibald Liversidge who was trained by the RSM & came to NSW at Sydney University & played a leading role as Professor of Geology from 1874 & Dean of the Faculty of Science (1879-1907). J. P.V. Madsen was fortunate in completing his BSc in 1899 at Sydney University that Liversidge had developed a very strong Faculty & in retrospect it is apparent that the confidence J.P.V.M demonstrated a few years later at Adelaide University in carrying out ground breaking experiments with radio-active substances including radium was in no small part due to his training at Sydney University.

CONTENTS.

PLATE 1 : HANS FRANDSEN MADSEN

SECTION 1.

H.F.Madsen's 18 inch reflector telescope & the sighting of the 2 tiny moons of Mars in 1892.

(Prepared by R.W.Madsen April 1995 & October 2019).

Introduction.

Hans Frandsen Madsen (1843-1937) whilst as a surveyor with the NSW Lands Dept. (1876-1913) developed an interest in astronomy dealing with the polishing & silvering of large glass blanks into spherical surfaces & used in one case in the construction of an 18 inch (46 cm) reflector telescope which he erected at his home "Hesselmed" in Queen Street Newtown & he is regarded as a pioneer telescope maker in the colony.

In 1892 Madsen's 18 inch reflector was used to observe the 2 moons of Mars (Deimos & Phobos) which had followed the first sighting of these 2 moons in 1877 by Asaph Hall at the U.S. Naval Observatory in Washington.

H.F.M was born in Jutland in Denmark on 26 February 1843 to parents who were farmers & was educated at the local public school of Janderup up to the age of 14 & then for 2 years by tuition in Varde, the nearby town whilst occupied as a junior clerk to the local Magistrate & Registrar. In 1861 he went to Copenhagen intending to sit for a Law Examination in February 1862, however he was unsuccessful in these exams & led to his migration to Melbourne & the goldfields.

Two famous Danish astronomers, Tycho Brahe (1846-1601) & Ole Roemer (1644-1710) had both been students & given lectures at the University of Copenhagen. The Tower Observatory at the University was constructed in 1642 & was a very noticeable structure & in retrospect this early contact in Copenhagen probably kindled an interest in astronomy.

H.F.Madsen's 18 inch reflector telescope-Polishing & silvering the specula.

In 1882H.F.M first began polishing glass specula flats & over the next 4 years he gradually mastered the technique of hand polishing well annealed glass blanks into spherical surfaces, ranging in diameter from 7 to 18 inches. The blanks were supplied from Birmingham, England.

With large specula, 3 plates of rough glass 1 inch thick & 18.5 inches in diameter were ground together to fit one into the other, & then cemented to form a firm & solid block. A completed 18 inch mirror with a plate glass cemented to the back for mounting weighed about 70 lb.

To produce the proper convexity, the large block was first hollowed out by using a leaden weight & rough emery. Next, using an iron tool specially made up with a convex shape about one quarter more than the concavity of the speculum, the 2 surfaces (iron tool & glass speculum) were then ground together & soon formed themselves into perfect spherical surfaces, & very nearly of the proper curvature.

The second process of smoothing, involved H.F.M using the finest grade of emery & sand to grind the glass to the desired form of convexity ie. Appropriate to the focal length. Smoothing continued until a

test with a pin hole of light showed a true & regular surface, accurate to less than 1/50,000 part of an inch.

The third process of polishing by hand to remove scratches was then carried out using 1 of 3 grades of pitch & using a polisher configured in a pattern devised by H.F.M. The most delicate part of the process then commenced to obtain a true spherical surface at the centre of curvature to a millionth of an inch. The technique adopted by H.F.M was by graduating the pitch polisher, which required great care to avoid running into an irregular curve.

The correct system of graduations for the curvature was to obtain 8 inches of spherical surface at the centre, &then as the curve receded to obtain a paraboloid by polishing with regular strokes for about 10 minutes, when the pinhole test was again made to check on progress.

H.F.M. found that the slightest touch or variation in temperature to the speculum was enough to destroy good definition under high magnifying power, irrespective of the disturbing effect of the atmosphere.

H.F.M. silvered his mirrors using Brashear's method, to a thickness of film of 1/200,000 th of an inch, & this required an absolutely even temperature. The technique of silvering glass for telescope mirrors was first developed by Leon Foucault in 1857. H.F.M's telescope was enclosed in a stone housing with a copper dome roof.

Polishing.

In the following 6 Figures, H.F.M. describes his method of polishing in detail.

Fig. 1. A piece of plate glass 10 inches in diameter was cemented to the back of the mirror to suit the cell or mounting, & the weight of the whole speculum when finished was about 70 lb.

Fig.2. Configuration of the pitch polisher graduated in squares as recommended in the "English Mechanic".

Fig. 3. The design of the pitch polisher devised by H.F.M. which avoided any rings forming on the glass even after hours of polishing only with a circular motion.

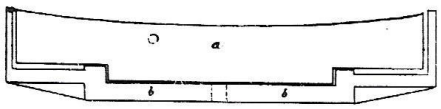
Fig. 4. To obtain the correct parabolic shape of the speculum where the outer edges of the speculum needed to be polished down, the pitch graduation on the polisher was configured with this pattern.

Fig. 5. When the centre & outer edges of the speculum needed to be polished down, the pitch graduation on the polisher was configured as shown.

Fig.6. When the centre & gradually receding to the outer edges needed to be polished down, the pitch graduation on the polisher was configured as shown.

After the specula had been coated with a very thin film of silver, H.F.M then carried out optical tests to ascertain that an even thickness had been deposited, otherwise the definition was impaired.

Fig: 1.



a. Speculum
b. Iron Cell

Fig: 2.

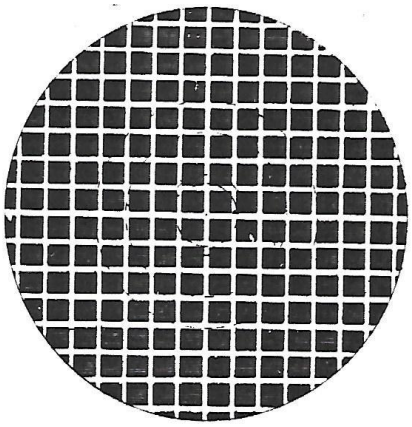


Fig: 4.

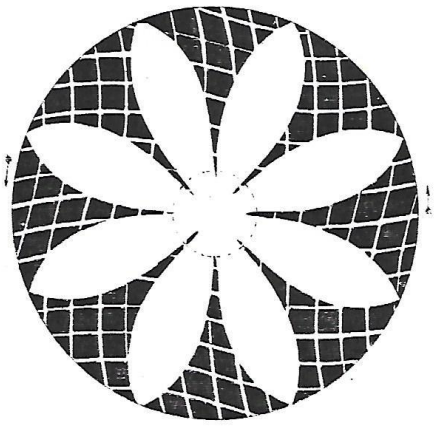


Fig: 3.
(Radius of Curves equal to Radius of Circle)

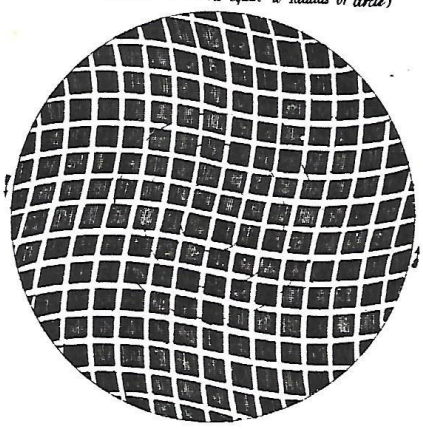


Fig: 5.

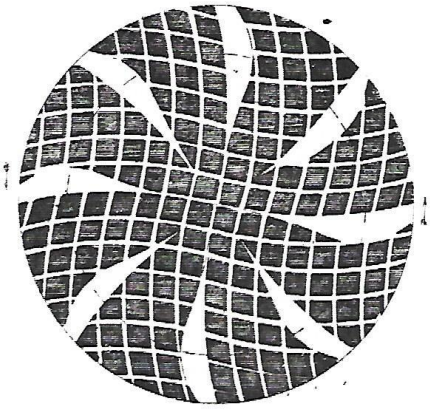
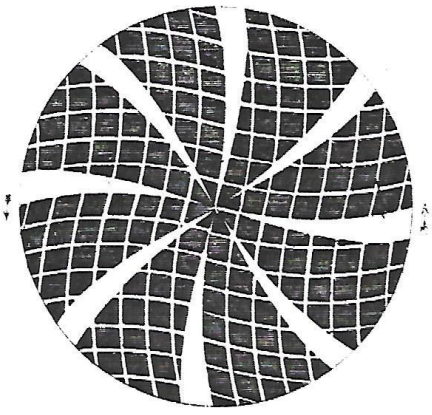


Fig: 6.



Scale - 2 Inches to One Foot

PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE,
SYDNEY, NEW SOUTH WALES.

The observation of the 2 satellites of Mars, Deimos & Phobos, in 1877 & 1892.

1. **The first observation of the 2 satellites of Mars in 1877 by Asaph Hall, Washington D.C**

When telescopic observations by Galileo on January 8, 1610 revealed that Jupiter, the next planet beyond Mars, had 4 satellites, Kepler & others speculated about the possibility of Martian satellites. The speculation was that if an orderly progression existed, starting from the Sun, Venus had no moons, Earth had 1, Mars was not known but now Jupiter had 4. Two moons for Mars seemed the correct assumption. Despite much searching, it was not until August 1877 when Mars was in opposition at a distance of about 35 million miles from Earth that Hall, using a 26 inch refractor at the U.S. Naval Observatory in Washington discovered a tiny satellite (the smaller moon) & the 6 days later a second, larger satellite. Both were very small, having diameters of only 17 miles (27Km) & 9 miles (15Km). Hall named the larger satellite "Phobos" & the smaller "Deimos" (Fear & Terror- the 2 sons of Mars).

2. **The 1892 opposition of Mars**

During the orbit of Mars about the Sun, it comes within 35 mil. Miles (56 mil. Kms) at its closest approach, but recedes to almost 250 mil miles (400 mil. Kms) so that it is not generally available for telescopic observation. The most favourable time to observe Mars by telescope is when Mars is in the opposite direction in the sky to the Sun, &when both Mars & Earth are closest in their orbit to the Sun. This occurs at an interval of approximately 2 years & 7 weeks. Because the orbital plane of Mars is 1.85 dgs to the Earth's orbital plane, such most favourable positions of Earth & Mars mean

that when observations are well placed in the southern hemisphere, the northern hemisphere will be badly placed, & vice versa.

3. Papers published in 1892-1893.

In August 1892 the opposition of Mars was to favour observers in the southern hemisphere & a circular request was issued by Dr.O. Lohse from Potsdam in July 1892, asking observers in the southern hemisphere to take measurements of the position angle of the polar caps of Mars.

In January 1893, the observation of the opposition of Mars made at the Royal Observatory, Cape of Good Hope, from June 28 to September 21, 1892, were published in the notices of the Royal Astronomical Society. No mention is made of any sightings of the 2 satellites, but this had not been specified as an objective.

In November 1892, Walter Gale at Paddington NSW, reported his observations of the Total Lunar Eclipse on November 4,1892 to the B.A.A (British Astronomical Society), but made no other reports at this time in the BAA, in relation to Mars.

In a map of the features of Mars prepared late in the 19th century, it is noted that "Mare Australe" is designated, which could be a reference to the oases of the planet, or small dark spots referred to as having been discovered by Walter Gale in 1892.

Except for the single reference in 1924 ("Sun" press item "Biggest not Best") to the observations using H.F.M's reflector, there does not appear to be any published paper in 1892-93 which describes this event. The papers of the Royal Society of NSW in 1892-93 do not include any papers by Walter Gale which may have contained a reference to the Madsen telescope observations. The work of John Tebbutt at Windsor in observing comets in 1891 & 1892 is however included in these publications.

Dr. Harley Wood, a former NSW Government Astronomer, has stated that he several times heard Walter Gale mention the Madsen 18 inch reflector as being a good telescope. Walter Gale made detailed observations of the planets, mainly with the 18 inch reflector when he had it.

4. Danish Astronomy & Copenhagen University 1642-1861.

It is evident that H.F.M's undoubted skill in astronomy can be traced to his origins in Denmark & particularly with the University of Copenhagen.

The University of Copenhagen was founded in 1479 & was responsible for the conduct of Legal Examinations, which had been introduced by Danish Law proclamation in 1736. H.F.M was unsuccessful in his Law Exams in February 1862 & led to his working on fully rigged sailing ships as an Able Bodied Seaman out of England until he worked his passage to Melbourne & the goldfields in 1864.

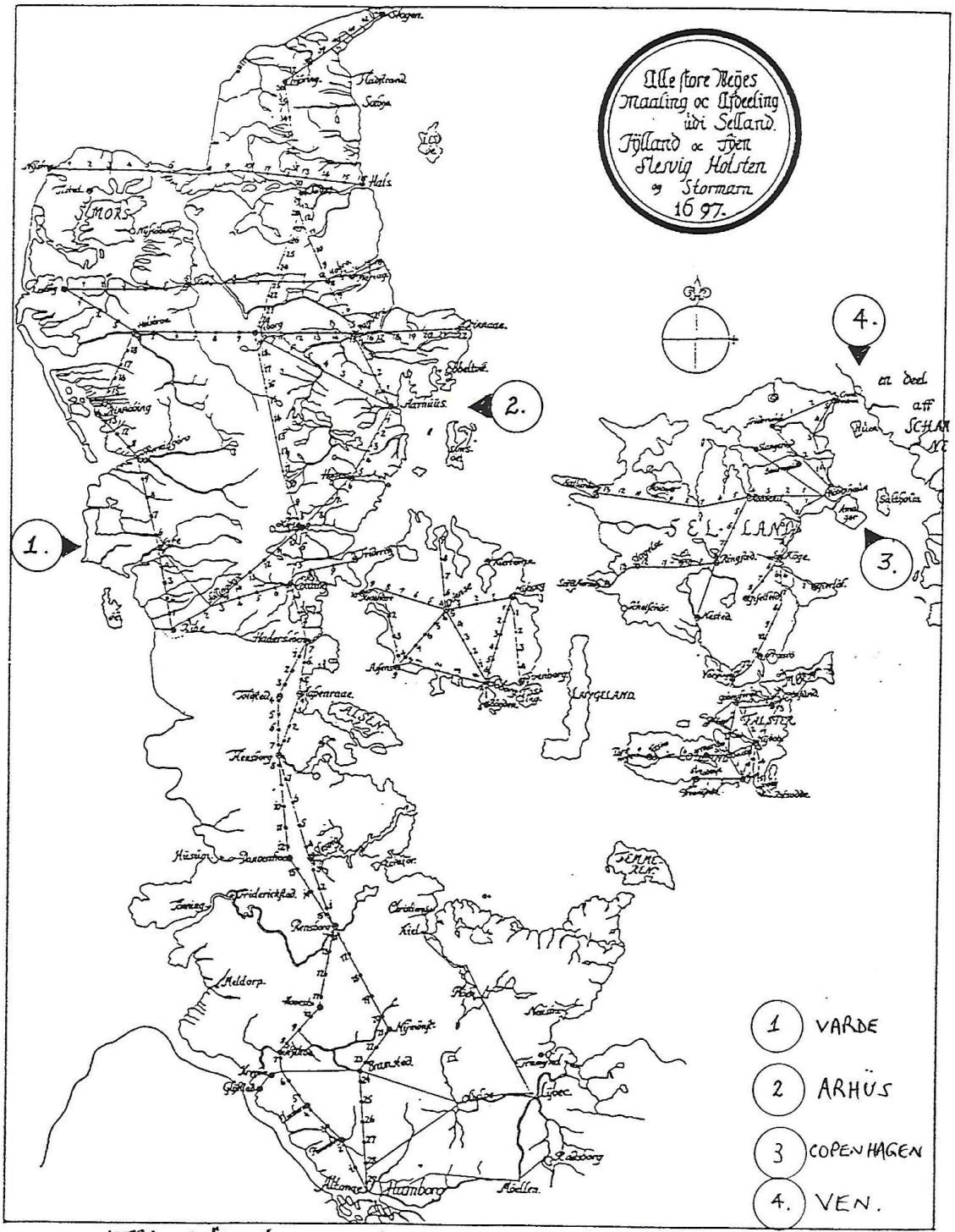
Whilst the short period of H.F.M's contact with Copenhagen was not immediately fruitful, in retrospect it does provide an explanation for his later activities, as 2 famous Danish astronomers, Tycho Brahe (1546) & Ole Roemer (1644-1710) had both been students & had given lectures at the University of Copenhagen.

The Round Tower Observatory at the University of Copenhagen was constructed in 1642 & is a very noticeable structure.

In 1576 Tycho built a large observatory on the island of Ven near Copenhagen & for the next 20 years used the splendid instruments he furnished it with & became the founder of accurate instrumental astronomy.Kepler at Prague from 1599 analysed Tycho's observations to find the true law of the motion of Mars, which had involved 6 years of incessant labour in mathematical calculations.

Ole Roemer was born at Arhus, Jutland in 1644, where he went to school prior to studying at Copenhagen University. In 1671 he assisted Picard from the French Academy to determine the exact position of Tycho's observatory on Ven, & the accompanied Picard to Paris. In 1675, based on his observations of the eclipses of the moons of Jupiter, which he noticed varied for each moon depending on the time of year: less in Spring & more in Autumn than usual. He proposed that this difference in apparent time of each eclipse was due to light having a definite velocity as represented by the time light took to travel across the diameter of the Earth's orbit, which as a first approximation was quite accurate as it was previously considered to be instantaneous. Roemer returned to Copenhagen in 1861 as Professor of Astronomy & Mathematics . He became interested in physical standards of measurement (weight, length, volume etc.) & built an observatory near Copenhagen with instruments he invented (transit instrument, mural circle, equatorial mounting of telescopes & other principal instruments used in observatories).

MAP OF DENMARK PREPARED BY OLE ROEMER IN 1697.



NOTE: 1 "MILE" = 10 KILOMETRES.

5. H.F.M. sailing in fully rigged sailing ships (1862-1864).

In 1862 H.F.M. obtained work in London on a fully rigged ship sailing to Canada, & prior to leaving had " procured in a second hand bookshop in London, a small dictionary, a grammar & a book of mathematical problems in navigation"-presumably involving the use of the sextant.

At the end of this voyage he was issued with a certificate AB (Able Bodied seaman) & was able to hold his own on any work required on fully rigged ships.

Subsequent voyages to America eventually led to work on a sailing vessel from Montevideo which arrived in Melbourne in January 1864, presumably via the Cape of Good Hope.

6. Mariner 9 (1971-72)& Viking (1976-80) satellite observations of the 2 battered moons of Mars.

It was not until the Mariner 9 mission (1971-72) that high resolution close up photographs of the 2 satellites of Mars were obtained. Until that moment no one had known what the surface of an asteroidal body would look like (eg. Polished smooth, dusted over as in the Moon, pitted with craters). The first telephotos of the 2 moons of Mars showed them to be heavily cratered bodies, with approximately as many craters per unit area as the most densely cratered parts of the Moon. Based on this information it is thought that the 2 moons may date back to the formation of Mars, billions of years ago. The orbits of the 2 moons are circular & lie in the plane of Mar's equator, rather than ellipse inclined at a high angle to the equator, which would be expected for a captured body. The 2 moons keep 1 side towards Mars at all times which indicates that no large impact has occurred to set the moons spinning within the last 100 mil years or so. Both moons have very dark surfaces equivalent to a dark basalt type lava. Phobos orbits Mars in about 7 hours 39 minutes.

QVADRANS MVRALIS
SIVE TICHONICUS.

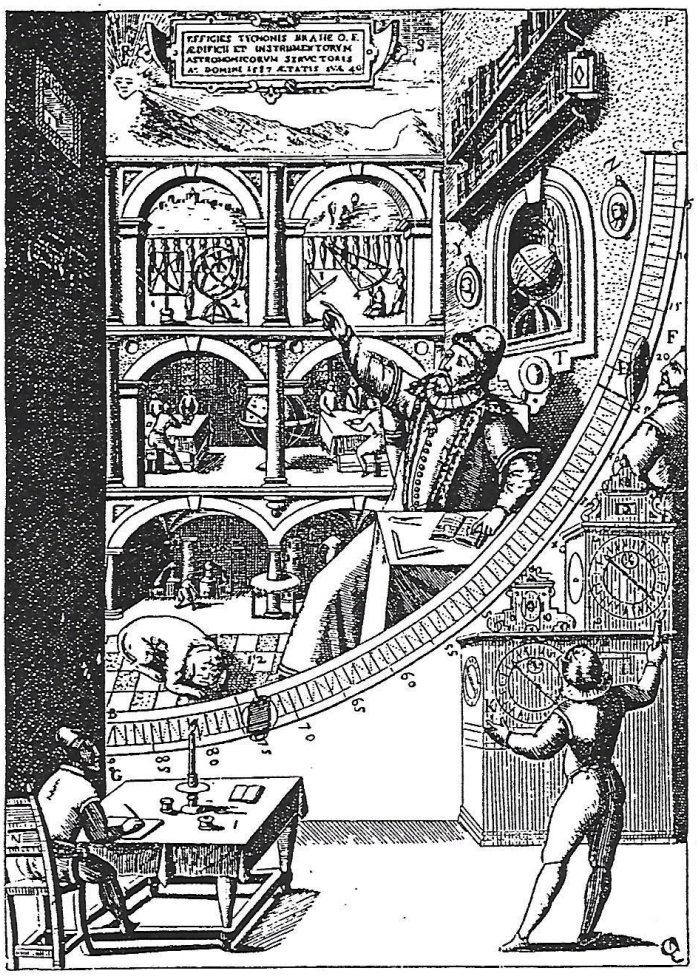


FIG. 24.—Tycho's form of transit circle.
The method of utilising the extremely uniform rotation of the earth by watching the planets and stars as they cross the meridian, and recording their times of transit; observing also at the same time their meridian altitudes (see observer *F*), was the invention of Tycho, and constitutes his greatest achievement. His method is followed to this day in all observatories.

The Round Tower Observatory of 1642 at Copenhagen University.

THE SUN, TUESDAY, AUGUST 26, 1924

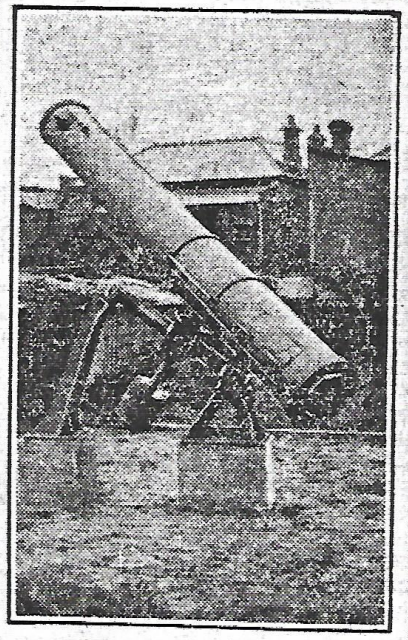
BIGGEST NOT BEST

Telescopes for Mars

ATMOSPHERIC OBSTACLES

The public, no doubt, wonders why a telescope sufficiently powerful has not been built to enable the observer to obtain an image of Mars sufficiently large for him to get a much closer and clearer view than those already obtained.

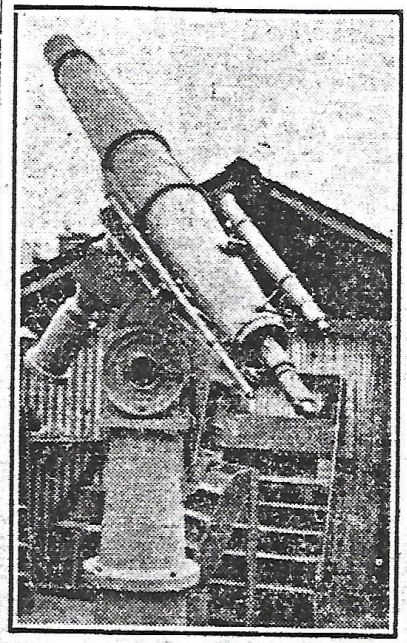
The trouble, as Mr. Walter Gale points out, is that the most powerful telescopes are of little value in observing the planet. In his observatory Mr. Gale employs two types of telescope, in one of which the image is formed by the rays passing through a compound lens, and in the other by reflection from a parabolic surface of silvered glass.



The 18in Equatorial Reflecting Telescope, through which Mr. Walter Gale is putting Mars under the third degree.

Each type has its special advantages, but for the amateur the great light grasp, purity of image, convenience and low cost are overwhelming arguments in favor of the reflector. With an instrument of this form of 8½ inches aperture Mr. Gale discovered in 1892 the small dark spots upon Mars which have since become famous as the oases of the planet.

It is true that the reflector is more sensitive to atmospheric disturbances



Another of Mr. Gale's instruments at Waverley—the eight-inch Equatorial Refracting Telescope by Grubb.

than the refractor, but in any case the best seeing conditions are essential to successful observation, as well as a trained eye.

The fine 8-inch equatorial refractor by Grubb, which for many years did excellent service in the hands of the late John Tebbutt, is one of the telescopes employed by Mr. Gale, while an 18-inch reflector constructed many years ago by Mr. H. F. Madsen, has recently been erected. With this latter telescope the tiny moons of Mars were revealed in 1892, and may again be seen during the coming weeks.

Unfortunately the larger the telescope the fewer are the nights that it can be used to advantage, for every imperfection of the atmosphere is increased by the very power of the instrument. Thus a large telescope is often a disappointment to the visitor, who expects to see much more than the night will permit to be revealed.

Experience and a night of good seeing conditions will, however, convince anyone of the value of large telescopes, and leave lasting memories of some of the most beautiful and impressive sights in the heavens.

SECTION 2.

Historical significance of the Madsen 18 inch (46 cm) reflector telescope.

(Prepared by R W Madsen October 2019).

Introduction.

Wayne Orchiston of U.S.Q (Toowoomba) & Colin Bembrick of U.N.S.W have written 2 excellent papers in 1987 & 1995 on “The contribution of the Lands Dept. to the development of astronomy during the nineteenth century" &”The role of the large reflecting telescope in amateur astronomy: an Australian case study.”

In these 2 papers the authors refer to H.F.M’s role as a telescope maker rather than as a serious observer & of his skill in producing the optics which he applied himself to with considerable ingenuity.

The contribution of the NSW Lands Department.

Avocational involvement by Lands Dept staff in astronomy between 1870-91 comprised mainly of members employed as Surveyors, Draftsmen & Computer whose interests involved Mathematical astronomy, Observational Astronomy, Popularisation of astronomy, Society activities & Telescope making (H.F.M).

Cook’s Tent Observatory.

All Field Surveyors employed by the Lands Dept, regardless of the branch in which they served, were required to have at least a rudimentary knowledge of practical astronomy.

In 1868 the Colony's 1st trigonometrical survey was commenced by surveying the base line at Lake George, which would serve as the reference point for the whole colony system & was carried out by the Government Astronomer, G.R. Smedley of the Sydney Observatory. In 1870 when Smedley died the survey was transferred to the Lands Dept. & by 1876 triangulation was extended from the base line & in 1879-80 a verification baseline was established at Richmond. Initially all astronomical observations were carried out with a transit telescope loaned by Sydney Observatory & a 13.5 inch theodolite.

In 1873 an 18 inch altazimuth instrument was ordered from Troughton & Simms (London) a very well known instrument making concern. With this instrument recalibration of micrometer screws was required from time to time as they were subject to wear with use. The large altazimuth instrument was housed in a portable tent observatory, 7 feet in diameter & mounted on a solid stone column. (Portable tent observatories had been used by astronomers on Cook's 3 voyages to the South Seas some 100 years earlier)

The astronomy that was carried out was strictly in the positional mould. Latitude was established by zenith observations of pairs of stars for which precise declination were known while longitude was determined by a telegraphic exchange of time signals between the survey stations & Sydney Observatory. Time at each survey was provided by a clock which was regulated by means of meridian transit observations of selected stars with accurately known right ascensions.

The number of staff in the Trigonometrical Survey Branch peaked between 1877-80 at an average of 13 (previously avg.4 & subsequently avg. 6) & the Sydney Observatory staff fairly steady at an average of 7.

Occasionally special astronomical projects involving Lands Dept. staff & not only those on the trigonometrical survey, involved cooperation with Sydney Observatory such as the Transit of Venus in 1874 & in 1881 for the Transit of Mercury. In 1882 the Transit of Venus marked the last occasion of active cooperation with Sydney Observatory.

The role of the large reflecting telescopes in amateur astronomy.

Orchiston & Bembrick consider 5 such telescopes however Bembrick with his close association with the Madsen 18 inch reflector as eventually the owner with intentions to refurbish & upgrade for planetary observing, however unfortunately these plans have not eventuated.

The history of the Madsen telescope appears to be as follows:

1882-1886. H.F.M makes a number of 46 cm mirrors, one of which is made into a complete telescope- a Newtonian with an English equatorial mounting housed in a circular stone building with a copper dome at H.F.M's house "Hesselmed" in Queen st. Newtown.

1895. Walter Gale has bought the Madsen reflector & is housed in a roll off roof observatory. The primary mirror is described as "Perfection".

1896. Gale moves to Newcastle with work & the telescope is left in Sydney & eventually dismantled.

1921-1941. Re-assembled & erected for planetary observing, & also Phobos & Deimos sightings.

1946-1974. McDowall purchases the telescope but is never mounted.

1980. Tyrell & Bembrick in partnership began restoring the mounting, however the steel tube is beyond repair.

1983. Bembrick becomes the sole owner with plans to redesign & restore the telescope (the “mirror very good, near perfect”). Restoration was never completed & last known to be in pieces in a barn west of Lithgow.

SECTION 3.

H.F.Madsen (1843-1937), J.P.V.Madsen (1879-1969) & The Royal School of Mines, London.

(Prepared by R. W. Madsen June 1, 2018.)

Introduction.

In March 1870 Sir Roderick Murchison (1792-1871) the Director of the Royal School of Mines (RSM) in Jermyn Street London advised Sir Redmond Barry (1813-1880) the Provisional President of the to be newly formed School of Mines Ballarat (SMB) that the curriculum used in London could be applied to Victoria with the slight modification that Natural History be replaced by studies in elementary mathematics & surveying both above & below ground.

It was fortuitous for Hans Frandsen Madsen who was one of the first students to enrol at the SMB in 1871 that both mathematics & surveying proved to be subjects he was good at & these skills were recognised by the First Master of SMB Mr. John Phillips C.E. who by condition of insufficient funds of the School after two years of initial operation decided to relocate to the Parkes-Tamworth areas of NSW as a surveyor & offered to take HFM as his assistant which was to lead in a short while for him to embark on a 37 year career with the NSW Lands Dept as a 1st class surveyor, a situation which was much better than having to work underground as a miner.

In 1867 Archibald Liversidge (1847-1927) [AL]was awarded a scholarship to the RSM for 3 years during which time the School's teachers & curriculum made an enormous impression on him & propelled his interests into mineralogy & mining. Liversidge spent a year at Christ's College Cambridge as a Demonstrator in Chemistry before taking up a position in 1872 at the University of Sydney as a Reader in Geology which by 1874 had led to him being appointed Professor of Geology at the University. Liversidge's remarkable career at the University through to 1907 included membership of the Royal Society of NSW, publication of a book "Minerals of NSW" in 1876 -3 eds.,1st Dean of the Faculty of Science (1879-1907), founding member of the Australasian Association for the Advancement of Science (AAAS) (1888), & founder of the NSW School of Mines (1892).

JPVM was the first student in an Australian University to concurrently complete the double degree in Science & Engineering (1897-1900) at the University of Sydney & was greatly influenced by the events at the AAAS meeting held in Dunedin in 1904 which was attended by W. H. Bragg (JPVM's Professor of Physics at Adelaide University) & Ernest Rutherford visiting from Montreal.

HFM was a member of the Royal Society of NSW & delivered a paper in 1886 on the hand polishing of 18 inch glass specula for use in reflector telescopes.

The Royal School of Mines, London.

Up to 1872 the RSM had its origins in the Government School of Mines & Science Applied to the Arts combined with the Museum of Practical Geology in Jermyn St which opened in 1851. The Officers of the Geological Survey (founded in 1835 as the Ordnance Geological Survey for producing maps for military purposes) became the lecturers & Professors of the School of Mines which had a name change in 1863 to RSM. The Geological Survey was the world's first national Geological Survey. The Museum was established in 1837 at the suggestion of Henry de la Beche.

In 1866 AL, (whose father was a carriage maker, & he had attended evening classes at the City of London College) obtained a Royal Exhibition Scholarship tenable for 3 years at the RSM & Royal College of Chemistry to the value of 50 pounds pa. & remission of all fees. He trained there under the following professors: Professor Frankland (Chemistry), Prof Tyndall (Physics), Sir Andrew Ramsay (Geology),Sir W. Warrington Smyth (Mineralogy), Professors Willis & Goodeve (Mechanics), Dr Percy (Metallurgy).[Professor Michael Foster at Cambridge(Physiology)].

On 15 March 1870, Sir Roderick Murchison FRS, the Head of RSM wrote to Sir Redmond Barry, the then acting President of SMB as follows:

"Jermyn Street

LONDON

15 March 1870.

My Dear Sir Redmond,

I was much pleased to receive your letter of 4th January, in which you do me justice in stating that I took especial interest in the mineral branch of the Victorian department of the Great Exhibition here in 1862; and I willingly accede to your request to give you my opinion regarding the best system to adopt in the establishing of a new mining school at Ballarat in Victoria.

I think that, with a slight addition and a certain modification, the curriculum of studies here may be very effectively applied to your colony; but you must add to the studies elementary mathematics, or at all events arithmetic, algebra and trigonometry, which we presume to be required by our students prior to their admission.

In a mining colony like Victoria, I think that surveying, both above & below ground, might with advantage be substituted for a course of natural history; for geology, including palaeontology and mineralogy, as well as metallurgy, being taught, pure zoology is scarcely called for in your Ballarat school.

I do not see that this curriculum need in any way interfere with the University of Melbourne.

I send you by this packet whatever books are at my disposal, which are few in number, as our Government limits presentation and author's copies to fifty for the world at large.

I remain

My Dear Sir Redmond

Yours most faithfully

RODERICK MURCHISON"

After 8 years of service in the Army against Napoleon, Murchison was influenced by Sir Humphrey Davy of the Royal Institution (RI), to turn his energy to science & he became fascinated by the young science of Geology. He joined the Geological Society of London & became acquainted with many prominent people including Charles Darwin & Charles Lyell.

In 1845 whilst visiting Cornwall he met several Cornish miners who were going to Australia & believing there might be gold there he asked them to send back samples, which they did, & thus Murchison knew of the existence of gold in Australia before Edward Hargrave's discovery in NSW in 1851. (The Murchison River in WA is named after him as are the Murchison Falls in Uganda).

Session 1857-8.

Arrangement of the Lectures.

Hour.	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
First Term. October, November, December, January, & February, and part						
10 to 11	Chemistry	Chemistry	Chemistry	Chemistry	Chemistry	Examination Day.
11 to 12						
12 to 1	Metallurgy		Metallurgy		Metallurgy	
1 to 2						
2 to 3	Physics	Physics	Physics			
3 to 4	Mining	Mining		Mining	Mining	
Second Term. Part of February, March, April, May, and June						
10 to 11			Natural History	Natural History	Natural History	Examination Day.
11 to 12						
12 to 1			Applied Mechanics	Applied Mechanics	Applied Mechanics	
1 to 2						
2 to 3	Geology	Geology	Geology			
3 to 4	Mineralogy	Mineralogy	Mineralogy			

90 Lectures on Chemistry ..... by A. W. Hoffman LL.D. F.R.S. 5th Oct. 1857 commencing
48 " Physics ..... " J. J. Stokes M.A. F.R.S. " 5th Oct. 1857
50 " Metallurgy ..... " J. Percy M.D. F.R.S. " 12 " "
60 " Mining } ..... " W. W. Smyth M.A. " 2nd November
40 " Mineralogy } ..... " W. W. Smyth M.A. " 15th Feby 1858
30 " Geology ..... " A. C. Ramsay F.R.S. " " " "
50 " Nat. History ..... " T. H. Huxley F.R.S. 17th " "
36 " Applied Mechanics ..... R. Willis. M.A. F.R.S. 17th " "

The Chemical and Metallurgical Laboratories will be opened for the Students on Thursday the 1st. of October, 1857.

Trenham Reeks, Registrar

Cornish Mining.

Because of the long standing importance of metal (particularly Copper & Tin) mining to the Cornish economy, classes for miners were started in Truro in 1839 & in 1858 The Miners Association began classes in different mining areas of Cornwall such as Camborne, Pool, St Just & St. Agnes. By 1863 some 200 students were attending classes in 11 mining education centres in Cornwall. Of note was the South Crofty tin & copper mine at Pool which made a fortune for the Bassett family over 20 years after 1710.

By the middle of the 19th Century Cornish mining was in decline & many Cornish miners emigrated to developing mining districts overseas where their skills were in demand such as South Australia & Victoria. In the 1st six months of 1875 10,000 miners left Cornwall to work overseas.

In September 1840, in South Australia, 2 Cornishmen discovered a vein of silver-lead ore at Glen Osmond in the Adelaide foothills & other discoveries were made & developed up to 1851 when miners joined a rush to the Victorian goldfields. Mining in South Australia was by traditional Cornish methods- Tut workers sank shafts & drove the levels & were paid by the amount of gold mined. The Tributers who developed & mined the stopes were paid by the value of ore produced. Gold was 1st produced in SA in 1846 & in 1852 at Jupiter Creek-also copper at Kapunda.

In 1848 the 1st Cornish engine house was constructed in Australia to handle the underground water & in 1849 a smelter was constructed for processing copper rather than sending bags of ore to Wales which was accounting for a high cost in shipping.

H. F. Madsen & Underground Mining at Buninyong & Ballarat (1864-1873).

At the age of 21 HFM had worked for 2 years on fully rigged sailing ships as an Able Bodied Seaman out of England, before arriving in Melbourne in January 1864. He then obtained employment at a deep mine called Garibaldy near Buninyong & later in 1869 moved to Ballarat sometimes working on top at the engine & sometimes underground. Prior to this he had caught typhoid fever & was unable to work for 6 months & had been given up by consultation with 3 doctors. In an endeavour to find something better to do he enrolled as one of the first students of the SMB located in Lydiard St. Ballarat.


THE SCHOOL OF MINES
BALLAARAT
ROLL BOOK

Ballaarat School of Mines

Pupils

Date of Entrance		Names at full length	Signature { on making Declaration CVII Act 2
1871			
Jan	25	Barrell, Samuel	
		Richards, Henry	
		Brünn, Ludwig	
	27	Pollard, Martin	
Feb.	1	Browne, Robert Cochrane	
	15	Treacy, Thomas	
March	8	Daffy, Cornelius	Hee Daffy
	29	Paul, William Newton	W Paul
April	3	McKee, Samuel D	
May	8	Desmond, Denis	Denis Desmond
	29	Madsen, Hans Frandsen	
June	29	Angove, W H	
July	17	McKenna, John J	see fol. 2
	24	Hore, John	see fol. 2.
		Sarjeant, Robert Malachy	
	31	Delpratt, Samuel	
		Templeton, Hugh	Hugh Templeton
			G. F. Walker

The School of Mines Ballarat 1870-1873.

The English method of self taught people & learning on the job for industrial applications in the early 19 th Century Industrial Revolution was evidenced by engineering works such as steam engines for pumps, railway engines, power as well as Cornish mining. Mechanics Institutes were first established in Scotland, Edinburgh in October 1821 (although a Brotherly Society had been founded in Birmingham in 1796 by local mechanics to fill a need) & they revolutionised access to education in science & technology for ordinary people. MI's followed in England in 1823 (Liverpool) & 1824 (London). In Australia a MI opened in Hobart in 1827- the MI in Ballarat started in 1859 & in 1870 representatives were included amongst those seeking to establish a School of Mines in Ballarat.

Sir Redmond Barry (1813-1880) born in County Cork & admitted to the Irish Bar in 1838, but unable to derive an income, arrived in Melbourne in November 1839. In 1851 after separation from NSW he became the Solicitor General & continued his very active mental & physical life. In 1853 he became the 1st Chancellor of the University of Melbourne & as a judge became well known for presiding over the cases of the Eureka Stockade rebels in 1855 & the Ned Kelly trial of 1880. He is regarded as a patron of Science in Victoria & in 1854 was the inaugural President of the Victorian Institute for the Advancement of Science. As indicated earlier Sir Redmond had requested advice from Sir Roderick Murchison on a suitable curriculum for a colonial School of Mines, however there is no indication in the records as to the qualifications that the Master of the new School should have & a matter of equal importance was as to how the new School was to be financed as State grants to a School outside of Melbourne were problematical, student term fees were initially proven to be less than 50% of the Master's requested remuneration & mining company contributions being of an entirely voluntary nature were not forthcoming.

In addition to the information received from the RMS, documents were also received in 1870 from Germany from the famous Mining Academy at Freiberg (Until 1969 Freiberg was dominated for 800 years by mining & smelting industries-it is located 179 km south of Berlin & 120 km NW of Prague) which had been in operation for well over 100 years supporting the extraction of iron, copper, tin, tungsten, lead, silver, cobalt, bismuth, uranium & manganese oxides. From the translation of the Freiberg document (not done by HFM who knew German) it appears that the State did not grant aid to the School of Mines, there appear to be 13 Professors & 4 teachers at the School most of whom have other appointments, the course takes typically 2-4 years to complete & there are 3 entry requirements viz.1. Proof of 1 years practical mining experience. 2.Provide a testimonial that the applicant is a steady, honest & industrious & moral man. 3. Must be of an age 18-22 years. [A famous student of the Freiberg Academy was Philip Deidesheimer (1832-1916) who in 1860 invented the Square Sets-honeycomb structure for underground mining first used on the Comstock Lode in Virginia City, Nevada]

The information on the course of instruction from the Royal Mining Academy of Berlin listed 24 different subjects involving 86 lectures by different professionals. Subjects dealt with were: Mining technology, Metallurgy, Assaying, Petrography, Mineralogical repetitions, Analytical geometry, Mechanical Science & Instruction in Drawing.

John Phillips C.E. (c.1825-1908).

John Phillips was to become the first Master of the new SMB in January 1871 at an agreed remuneration of 400 pounds pa. to be paid out of student fees & any deficiency or surplus to be settled by the Council.

Phillips taught Mathematics & Surveying & the only other instructor was Joseph Flude who lectured on Chemistry on an honorary basis for 2 hours on Tuesday & Thursday evenings. The versatility of Mr Phillips under this arrangement was crucial, however after 18 months of operation to 30 June 1872 the Council observed that nothing seems to have been done towards giving instruction to the pupils in Geology & Mineralogy.

The career background of Phillips prior to August 1861 when he ran unsuccessfully for election in the Ballarat district for the Legislative Council proposing at that time that a School of Mines be started in Ballarat is unclear. It appears that he was born in Cornwall to mother Jane (family name not known but who came from Ludgvan, Cornwall) & was married to Caroline Robarts Bromley & had several children who travelled to Melbourne some years after John. Caroline died in Ballarat in 1876 & HFM refers to a daughter being in the house at Parkes with her Father at about this time. HFM refers to Phillips as being a "scientific" man & newspaper articles from 1856 on his efforts refer to his invention of a special compass, purifying water from swamps, a paper published in London in 1858 on "the goldfield of Ballarat", mine safety, irrigation & agriculture.

From 1864 to 1870 Phillips was the contract Government Mining Registrar & Surveyor for the North St Arnaud District in Victoria from where he applied in December 1870 for the position of Master at SMB on a remuneration of 400 pounds pa.. There is no information on the second person who applied for the position. In a 1864 quarterly report to the Government Phillips reports that the district has 753 miners working with alluvial & quartz mines with 98 stamp heads & 12 puddling machines for the alluvial.

In January 1873 when his role at SMB had come to an end over disagreement regarding fees & finances he advertised his new Polytechnic School at 2 Albert St. where he would teach "Artisans, Builders, Engineers, Farmers, Mechanics, Miners, Surveyors & other general pursuits" but this did not prove to be successful & he appears to have moved to the Central Western districts of NSW (Orange, Tamworth, Parkes) with HFM whose mathematical & drawing abilities were recognised by Phillips. The move to Parkes no doubt was influenced by a gold discovery there in 1871 and later at what was known as "Bushman's Gold Mine", the area being named "Parkes" in 1873.

Phillips was said to have a "quaint but genial enthusiasm to his methods of teaching". In August 1872 Phillips reported to Council on the scope of instructions as follows:

"The instruction to Surveying & Engineering classes has embraced arithmetic, mensuration, logarithms, trigonometry, Euclid's elements, algebra to quadratic equations & their application to surveying, levelling & engineering, plotting, mapping, topography, use & adjustment of instruments, mechanical & perspective drawing from specifications, isometric drawing, projection, mine planning, projection of workings, cross sections, with all calculations & checks connecting surface with underground lines, mine boundary questions as cases of arbitration surface surveying, levelling & construction on paper, courses of land surveying such as Gillespie's. He noted also that the funds of the Institution were such that the Institution is destitute of many of the helps & essentials to ready instruction.

John Phillips resident Master".

The SMB conducted examinations in June & November for the purpose of testing for the pass of the following certificates: Mining Surveyor, Mining Engineer, Assayer, Inorganic Chemistry, Captain of Shift, Underground Manager, Engineer & Engine Driver. There is no record up to the end of 1872 that HFM

was awarded a Certificate (but the records for this time may not be complete). The number of students at the SMB at the end of 1871 was 40 (by the end of 1872 had improved considerably to 66) with fees being one pound one shilling per term (4 terms).

In February 1876 HFM went to Sydney from Parkes to sit for the Licensed Surveyors exam & was accepted as a candidate & passed 3rd out of 15 which was far better than expected by him & was offered a position as a Surveyor with the NSW Lands Dept. with whom he continued to work until his 70th birthday in 1913 when he then drew his pension for the next 24 years, taking out much more than he put into the superannuation fund. HFM speculated that Phillips may have taken up a position in Qld. As a Govt. Geologist, but that is only what he heard.

<u>School of Mines in NSW.</u>

Soon after his arrival in NSW Archibald Liversidge (AL), published 3 long letters to the Sydney Morning Herald. On December 6, 1872 in his maiden address to the Royal Society of NSW he proposed that the curriculum of the RSM be adopted for NSW. In February 1873 he dealt with Mining Schools at various locations overseas eg. at Bristol, Truro, Dublin, Columbia University in New York, Freiberg, Berlin, Paris & Yale. On February 28, 1873 he proposed a Science School for the University of Sydney & referred to the Princeton School of Science. AL preferred the Royal College of Science Dublin & the Continental

Institutions rather than the RSM. (London did not receive a combined Mining & Science School until 1907 with the establishment of Imperial College).

A School of Mines for NSW had been proposed over 20 years up to 1892 without success apparently because it was felt that the gold discoveries had all been worked out & it was not until the needs of coal mining began to emerge that a School of Mines was started at Sydney University by AL. It apparently was felt that Schools such as Ballarat could supply whatever mining professional may be needed.

The book "Archibald Liversidge: Imperial Science under the Southern Cross" by Roy Macleod (Royal Society of NSW & University of Sydney Press) can be viewed online at the University of Sydney, Science About Us, website. This book very fully deals with all aspects of Liversidge's wonderful work which a contemporary remarked on his passing in 1927 was that " AL was certainly the greatest organiser of science that Australia has seen & surely no one in that country worked more unselfishly & with greater singleness of purpose than he to serve science for its own sake".

AL was one of the 1st to detect gold & platinum metals in meteorites- he was a shy & retiring man & never married-he gave successful & impressive practical demonstrations but was not a fluent speaker. When he retired in 1907 he returned to London where he continued his interest in Chemistry & worked in the Davy –Faraday Laboratory at the RI.

It has been noted that in regard to his book on "The Minerals of NSW" he was mainly interested in the chemical composition of minerals but that the absence of their detailed crystallography & optical properties reduced the usefulness of the book.

<u>Faculty of Science at the University of Sydney.</u>

In the 1883-84 Calendar for the University dealing with the By-Laws for the Faculty of Science there is a requirement that a student complete 9 terms of subjects over 3 years including subjects in Chemistry, Physics, Natural History, Mathematics, Mineralogy, Geology, Palaeontology, Zoology & Botany. The Dean of the Faculty has to sign a certificate for a BSc degree that prior to examination the student has passed all examinations since entry into the University. A DSc degree required a further 3 years of scientific study & research.

The Department of Engineering provided for 3 certificates viz. Civil & Architecture, Mechanical & Mining taking 4 years & the Dean of the Faculty of Science had to certify that 12 terms of study had been successfully completed.

Deans of Faculties were appointed by the Senate for 3 year terms. By 1879 AL had persuaded the University Senate to open a Faculty of Science & he was the first Dean from 1879-1907. The Science subjects such as Physics, Mathematics, Geology, Chemistry & Mineralogy previously formed part of the Faculty of Arts.

The Academic record of JPVM in achieving the double degree in Science & Engineering (1897-1900) with University Medals in Mathematics & Civil Engineering is dealt with at the University of Sydney website "Beyond 1914".

One aspect of JPVM's work in scientific research at Adelaide University (1904-08) & at the University of Sydney (1909-11) was in respect of the handling of Radium & I believe that his grounding in Chemistry & Geology as part of his BSc degree at Sydney University contributed towards the confidence with which

he undertook 1st class experiments in the field of atomic structure in conjunction with W H Bragg, in fact this work possibly would not have come about except for the existence of the AAAS which AL was instrumental in founding in 1888. The AAAS meeting in Dunedin in 1904 where WHB was asked to give a Presidential Address in the presence of Ernest Rutherford who was visiting from Montreal started Bragg on an entirely new career in fundamental scientific research.

The photo of J.P.V. M at Sydney University probably in 1909 on taking up his position as Lecturer in Electrical Engineering.

The Royal Society of NSW.

In 1872 AL joined the Royal Society of NSW & got things moving- he was President in 1886, 1890 & 1901 & it was in 1886 also that HFM as a member presented his paper on the hand polishing of 18 inch specular for reflector telescopes. (see Google: “Victoria Collections-H F Madsen-Pioneers of Ballarat”).

It is believed that HFM assisted Lawrence Hargrave who was also a member of the Royal Society of NSW with his kite experiments in the Royal National Park.

J.P.V.M Sydney University photo. c.1909.