Geophysical instruments in the National Historical Collection

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In 1978, geology and geophysics staff from the Bureau of Mineral Resources went about assembling a collection of historical geophysical equipment, described by Peter Sydenham to be '...the most extensive assembly of historic geophysical apparatus in Australia' (Sydenham 1978, p. 243).

Since that time the collection has become part of the National Historical Collection and has been significantly expanded through the addition of instruments from the Australian Geological Survey Organisation and Geoscience Australia. Today, it comprises over 800 instruments and archival items representing the full range of Australian Government geophysical activity through the 20th Century and into the 21st Century.

The National Museum of Australia (originally Museum of Australia) was established by the National Museum of Australia Act of 1980 'to develop and maintain a national collection of historical material…in the national interest' which was to be known as the 'National Historical Collection'. The act provided for the transfer of existing Commonwealth collections, such as the Australian Institute of Anatomy Collection, the National Ethnographic Collection and collections held by the departments of Home Affairs and Transport to the National Historical Collection (Hansen 2005, pp. passim). After a series of discussions between National Museum and Bureau of Mineral Resources staff, the Bureau of Mineral Resources Collection was also transferred to the new museum, in July 1986. This material comprised superseded equipment that had been saved from the normal stores disposal process by Max Allen and colleagues, from the early 1950s to the early 1980s. Most had been made obsolete by technological advances in survey techniques or simply replaced by more modern equipment (Shephard 1999).

The National Museum names its collections for the donor or the transferring government body. Thus, the geophysical equipment in the National Historical Collection is found in six different individual collections – Bureau of Mineral Resources Nos 1 and 2, Dr Liz Truswell, Australian Geological Survey Organisation and Geoscience Australia Nos 1 and 2.

Australia's National Geological Survey

The earliest recorded Commonwealth Government involvement in the geological sciences was examination of the site for Canberra in 1910 by Edward Fisher Pittman (1849–1932) of the New South Wales Mines Department (Vallance 1988). The first Commonwealth geological staff appointment, however, was that of Evan Richard Stanley (1885–1924) as Government Geologist in Papua in 1911 (Smith 2007). Despite representations from scientific and other professional bodies about the importance of a national scientific investigation of Australia's mineral resources the Commonwealth of Australia was nearly five decades old before a Commonwealth Geological Survey was formed. Prior to this, however, the Carnegie Institution of Washington's Department of Terrestrial Magnetism established a magnetic observatory at Watheroo in Western Australia; the Imperial Geophysical Experimental Survey was formed in 1928 to test the applicability of various geophysical survey methods under Australian conditions; and from 1934 to 1941 the Aerial, Geophysical and Geological Survey of Northern Australia investigated selected areas of promise for mineral discovery including the testing aerial photography methods in Western Australia (Wilkinson 1996, pp. 12–27; Crespin 1971, pp. 29–46).

There are instruments from each of these initiatives in the Bureau of Mineral Resources Collection, including magnetometers, an Oertling gradiometer and two Hilger & Watts variometers that were used by Jack Rayner (1906–82) (McCracken 2012), who later became Director of the Bureau of Mineral Resources (Figure 1).

The Bureau of Mineral Resources, Geology and Geophysics was established in 1946. Its primary aim was the systematic geological and geophysical mapping of Australia to assist informed mineral exploration. The new agency also assumed responsibility for the Watheroo Magnetic Observatory previously operated by the Department of Terrestrial Magnetism. In the early 1970s, with the systematic mapping of Australia nearing completion, the Bureau of Mineral Resources turned its attention to mapping the continental shelf and slope. Onshore work focussed on detailed geological, geophysical and geochemical studies of specific mineralised areas (Wilkinson 1996, passim).

Fig. 1. *Watts variometer no. 15887, dating 1935. Implementation: Used on AGGSNA survey of Tennant Creek (1935) and later on Cocos Island (1946) and Macquarie Island (1950–52). Image: National Museum of Australia, 2007.*

In 1978, the Bureau of Mineral Resource's primary role moved toward strategic research, with an emphasis on the search for offshore petroleum reserves, and away from surveying and mapping. During the early 1980s, it developed its expertise in remote sensing and groundwater investigations and commenced nuclear monitoring and geohazard assessment. The Bureau became the Australian Geological Survey Organisation in 1992. Geoscience Australia was formed in November 2001, combining the previously separate agencies of Australian Geological Survey Organisation, the Australian Surveying and Land Information Group (formerly Australian Survey Office and National Mapping) and the Australian Centre for Remote Sensing (Geoscience Australia 2012). All of these agencies are represented in the National Historical Collection.

Bureau of Mineral Resources Collections Nos 1 and 2 and Dr Liz Truswell Collection, 1986–1999

It is difficult to quantify the number of instruments transferred to the National Museum in 1986 as no consolidated listing was made at the time, although the Receipt Authority Vouchers and Crate Lists did give some idea of its extent. Reference was made to 58 crates containing about 650 types in storage at Oaklands, north of Mulwala, as well as to items in store at Fyshwick and in the BMR building at the time of transfer. The only instruments mentioned either individually or generally were those of obvious historic significance (National Museum of Australia collection file – Bureau of Mineral Resources No. 1).

In May 1977 Dr Peter Sydenham and a team from the University of New England examined 110 items stored at Oaklands. He prepared catalogue sheets recording the physical description, condition, purpose and past use (when known) as well as placing a label on each of the instruments. Eight years later, in September 1985, Max Allen and four members of the Bureau of Mineral Resources Historic Collection Committee inspected a representative sample of the collection over two days. The results of this review are outlined in two reports prepared by Max Allen who, in part, recommended that 'a reappraisal and stocktake of the collection should be made' to ensure that all systems were complete and to remove items which had no value for 'geophysical museum purposes'. He went on to recommend that the instruments should be grouped into categories covering the various geophysical techniques. These recommendations were not acted on until after the collection was transferred to the National Museum and then only in part.

The collection has been developed since 1986 by adding equipment and removing items that were duplicated, degraded to a point where they could not be restored or of unknown origin.

In 1991 and 1992, two petrological microscopes and a swivel chair used by Irene Crespin were added to the National Historical Collection (National Museum of Australia collection files – Bureau of Mineral Resources No. 2 and Dr Liz Truswell). Irene Crespin (1896–1980) was Assistant Commonwealth Palaeontologist from 1927 to 1936 and Commonwealth Palaeontologist from 1936 until her retirement in 1961. From 1946 her position was attached to the Bureau of Mineral Resources in Canberra. Crespin was heavily involved in the search for oil for three decades (Bartlett 1993).

The first attempt to provide a consolidated listing of the collection was made in 1997 when National Museum staff examined, identified and labelled individual and grouped items from it. They were greatly assisted in their work of identifying instruments by a set of *Vocabulary of Stores* books – these list instruments with an identifying number, which is generally marked on individual instruments – and the catalogue sheets prepared by Peter Sydenham in 1978 (Shephard 1999; Department of National Development 1962).

Fig. 2. *Oertling gradiometer no. 21636, dating 1928. Implementation: Used on the Imperial Geophysical Experimental Survey. Image: National Museum of Australia, 2006.*

Fig. 3. *Sharp personal torsion magnetometer. Image: National Museum of Australia.*

Fig. 4. *Hunting Adastra Gulf airborne magnetometer. Image: Denis Shephard, 2012.*

Electrical and electromagnetic equipment in the collection includes an electromagnetic compensator system built by Bureau of Mineral Resources to the basic design of original instrumentation used by the Aerial Geological and Geophysical Survey of Northern Australia; several sets of Slingram and Turam equipment manufactured by the Electrical Prospecting Company of Sweden; and a Hunting-Canso airborne electromagnetic system used by Adastra-Hunting in the late 1950s and the 1960s that was given to the Bureau for the collection in 1983. It is possibly that the latter was used in Australia under contract to Rio Tinto Exploration Company in Western Australia and Queensland circa 1956-57.

Gravity equipment in the collection includes Askania torsion balances presented to the Bureau of Mineral Resources by Vacuum Oil in the 1970s; an Oertling gradiometer used by the Imperial Geophysical Experimental Survey during 1929–30 (Figure 2); and Holweck-Lejay inverted pendulums used for gravity base work by Shell (Queensland) Development Pty Ltd in southwest Queensland in 1940–42.

There are about 80 magnetic instruments in the collection, illustrating the evolution from mechanical to electronic equipment. They include a Sharp personal torsion magnetometer (Figure 3); dip circles; absolute magnetometers; a Watts variometer that was one of three used in exploratory magnetic surveys by the Aerial, Geological and Geophysical Survey of Northern Australia (Figure 3); variometers of British

Fig. 5. *CAE Model 965 scintillometer. Image: National Museum of Australia, 2012.*

and German design dating 1935 to 1955; and a fluxgate magnetometer of the type developed by Gulf Oil in 1951 and used by Hunting Adastra during contract aeromagnetic work for the Bureau of Mineral Resources from about 1956 until the early 1960s (Figure 4).

Fig. 6. *Surveying using plane table and alidade. Image: Geoscience Australia, no date.*

Radiometric equipment in the collection includes a Chalk River scintillometer used by the Bureau in the radiometric surveys of Rum Jungle and other uranium provinces of the Northern Territory; a CAE Model 965 scintilometer (Figure 5); and portable geiger counters and ratemeters developed and marketed by Austronic Engineering Laboratories in Melbourne and used throughout Australia.

Seismic equipment in the collection includes a Cambridge Institute sound-ranging set with telephones dating from around 1916; and a Mid-Western reflection set for marine used from the 1960s.

This initial transfer also included theodolites, plane tables, alidades (Figure 6); sextants; and a chronometer that was used on Heard Island in 1947 (Figure 7). Another interesting item is a vehicle odograph, with its components still in their original packaging. The odograph was developed by the United States of America's Corps of Engineers during WWII as a vehicle navigation system. It could plot to any scale between 1 to 20 000 and 1 to 500 000, making it possible to draw a route map showing all the roads in a specified area to the same scale as a topographic map, to an accuracy of one to three percent. Its proposed use by the Bureau is still being investigated.

Two years later, in 1999, following the first systematic examination of the items stored at Oaklands by museum staff, a large number of duplicate representative instruments and miscellaneous unidentifiable items were removed from the

Fig. 7. *Remains Heard Island Base, February 1980. The collection includes a chronometer and theodolite-magnetometer used on the first scientific expedition to Heard Island in 1947. Image: Geoscience Australia.*

Fig. 8. *Scintrex DHP-4 electromagnetic drill-hole probe. Image: National Museum of Australia.*

National Historical Collection. At the same time the collection was transferred from Oaklands to the National Museum's repository at Mitchell in Canberra.

Australian Geological Survey Organisation Collection, 1999

In 1999, the Australian Geological Survey Organisation transferred 85 instruments plus 79 technical manuals and some archival material to the National Museum (National Museum of Australia collection file – Australian Geological Survey Organisation). The instruments included McPhar Model P650 induced polarisation equipment; a Scintrex DHP-4 electromagnetic drill hole probe (Figure 8); a Littlemore Type 781 magnetometer; a Type 1183A dosimeter, Serial No. 1274; BMR Type KSS-1 salinity sampler; two Topoplastic circular slide rules ($V = V_o + at$ and $V = V_o + K_z$); a Unicom electronic microscope (Figure 9); and a Waterworth plotting stereoscope.

The plotting stereoscope was designed and built by Eric Newham Waterworth (1905–90), optical and scientific instrument maker of Hobart, in consultation with Professor Samuel Warren Carey (1911–2002) of the Geology Department at University of Tasmania in the early 1950s. It was used for geological photo-interpretation work but was also suitable for forestry work. The stereoscope was purchased by CSIRO Forest Research at Yarralumla and transferred to the Bureau of Mineral Resources in 1983.

Geoscience Australia Collections Nos 1 and 2, 2004–2008

In 2004, Geoscience Australia transferred a Sun 2 computer system, plus associated manuals to the National Museum (National Museum of Australia collection file – Geoscience Australia No. 1). Nicknamed 'Annie', it was installed in the Bureau of Mineral Resources' seismological centre in Canberra in 1984 where it played a key role in the Bureau's nuclear explosion monitoring program until being decommissioned in 2002. 'Annie's' role was to retrieve and analyse data from the Alice Springs seismic array, which was jointly run with the United States of America Air Force. By 2002, however, it was no longer able to meet the storage demands of the work and was replaced by a system of larger capacity.

Finally, in 2008, Geoscience Australia transferred 71 instruments used in a range of geomagnetic, seismic and laboratory work to

Fig. 9. *Part of Unicam electronic microscope no. 398522. Image: National Museum of Australia, 2012.*

the National Museum (National Museum of Australia collection file – Geoscience Australia No. 2). They included a dip circle, magnetometers, a Benioff seismometer and survey chronometers.

The Lloyd Creek dip circle, serial no. 149 (Figure 10), was made sometime prior to 1904 and was purchased from Sir Douglas Mawson in 1950 for use on Heard Island. However, following testing at Toolangi Magnetic Observatory by RE Ervin, it was found to be unserviceable. Verification of the general, but not universal, acceptance of its use by Mawson in Antarctica continues. The Carnegie Institution of Washington magnetometer serial no. 7, made by Bausch, Lomb and Spegmuller of Rochester in New York in 1908, was used as a standard instrument in the Watheroo Magnetic Observatory from 1919 to 1953.

The Benioff seismometer, comprising a set of three instruments (Vertical, North/South and East/West) was imported from the United States of America in about 1956 and installed in the old Melbourne Observatory. Subsequently, it was shifted to

Fig. 10. *Lloyd-Creak dip circle no. 149. Acquisition: Purchased by Bureau of Mineral Resources from Douglas Mawson in 1950. Image: National Museum of Australia.*

Green Mount near Toolangi in 1962. Before the station went automatic in the 1980s Ron Biggs, a local farmer, would take daily readings for the seismic section of the Bureau of Mineral Resources. Mr Biggs monitored both the magnetic and seismic observatories at Toolangi for over 50 years, from 1952.

Survey chronometer 18786, a standard two-day survey chronometer made by Thomas Mercer in about 1949/50, was used at Mawson Magnetic Observatory, Antarctica, in the 1970s. Like the other Mercers with Antarctic connections in the National Historical Collection, this machine was used as a laboratory time-reference, after being set by radio time signals. On at least one occasion, in January 1976, its time was checked against a reference signal broadcast from Radio VNG. The receiving and broadcasting equipment of Radio VNG are also now part of the National Historical Collection.

Also transferred was an EDA FM-105B fluxgate magnetometer that was used in the search for the South Magnetic Pole in the Southern Ocean on MV *Icebird* in 1985 and MV *Hubert Wilkins* in 2000 (Barton 2001, pp. 26–27); Mawr 2006, pp. 260–265); Askania horizontal variometer 520313 used at Mundaring Magnetic Observatory; and LFE Plasma Asher used in the Organic Geochemistry Laboratory of Offshore Petroleum Exploration in the analysis of sediments to assist in the offshore search for petroleum deposits.

Geophysical instruments and the National Historical Collection

The result of these various transfers and removals is a collection of individually significant and generally representative instruments that illustrates the work of the Bureau of Mineral Resources and its predecessors and successors through the 20th century. The collection also documents the history of significant Australian geophysical survey equipment; documents Australian innovation and inventiveness in geophysical survey equipment; and contributes to an understanding of the evolution of scientific instruments generally.

Several instruments and/or systems in the collection relate directly to Australian relations with the international scientific community. For example, there are about 20 instruments from Watheroo Observatory, including chronometers, magnetometers a spectrohelioscope and a Toepfer earth inductor. Watheroo was established by the Carnegie Institution of Washington in 1919 and transferred to the Bureau of Mineral Resources in 1947. It played a central role in Australia's participation in the International Geophysical Year of 1957–58 in which over 50 countries combined in an international project of universal scientific exploration and research designed to increase knowledge of Earth and the physical forces that influence it (Wilkinson 1996, p. 141). These 20 instruments may constitute the single largest holding of out-of-use magnetic equipment used by the Carnegie Institution. By comparison, the Smithsonian Institution's website indicates that its collection contains only five or six items relating to the geomagnetic work of the Carnegie Institution. One important instrument missing from the collection is the Eschenhagen magnetograph that is currently on display in the foyer of the Geoscience Australia building at Symonston. This instrument operated continuously at Watheroo and Mundaring observatories from 1919 to the 1980s.

The Bureau of Mineral Resources' observatories on sub-Antarctic islands and on Antarctica have also played important

roles in international geophysical research activities. There are items from these observatories in the collection, including survey chronometers, a marine chronometer, a magnetometer and variometers.

As a whole the collection generally reflects the working lives of field and laboratory geophysicists employed by the Australian government. Some instruments and/or systems can also be related to specific people. For example, Seitz Waterlander who worked as a geophysical observer with the Holweck-Lejay inverted pendulums on gravity surveys in southwest Queensland in 1940–42.

A number of other Australian collecting institutions have small but important holdings of geophysical surveying instruments. In 1999, for example, the Australian Museums On-Line database (AMOL) showed three records under 'geophysics' and 15 records under 'magnetometer' as well as 215 under 'geology'. None of these collections, however, covered the full range of geophysical prospecting techniques. Nor did they have a national provenance. The successor to AMOL - Collections Australia Network - shows nil relevant entries when searched on these terms. More research is needed to provide an exhaustive consolidated listing of holdings throughout Australia.

Conclusion

In May 1978, Dr Peter Sydenham argued that the collection he examined was a

> *...significant part of Australia's technological heritage... [should] be made more available to the public, for it presents a significant amount of national activity in the more modern era of the earth science* (Sydenham 1978, p. 243)

Fig. 11. *EDA fluxgate magnetometer displayed in Quest for the South Magnetic Pole, at the South Australian Maritime Museum, July 2009. Image: South Australian Maritime Museum.*

As outlined above, the collection has grown significantly since then. It is only in recent times, however, that Sydenham's plea has been acted upon. About 500 instruments from the collection are currently displayed on the National Museum's homepage (http://www.nma.gov.au, verified 7 March 2013), but with only minimal information about each. Unfortunately, there is no reference to the richness of stories behind either the collection as a whole or of individual instruments within the collection. Beyond the website, only about 10 instruments from the collection have ever been placed on display. The 'Rocks to Riches' module of the Museum's Nation Gallery (now closed) included about eight instruments while the 'Quest for the South Magnetic Pole' travelling exhibition developed by the South Australian Maritime Museum in 2010 included the EDA fluxgate magnetometer (Figure 11) and dip circle 149.

Much more could be done to increase public access to this nationally significant collection of geophysical equipment.

In following articles I will examine aspects of the collection in more detail, commencing with equipment brought to Australia by the Carnegie Institution of Washington's Department of Terrestrial Magnetism.

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