

William Compston FAA FTSE FRS (19 February 1931 – 16 May 2025)

MALCOLM MCCULLOCH¹, IAN WILLIAMS²

¹ Oceans Institute, The University of Western Australia,

² Research School of Earth Sciences, Australian National University

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William (Bill) Compston was a physicist/isotope geochemist/geochronologist who made pioneering developments in the dating of minerals and rocks from the ancient Archean rocks of Australia and later in establishing the chronology of the Lunar basalts collected by the Apollo return missions. He is best known for the revolutionary development and construction of the Sensitive High Resolution Ion Micro Probe (SHRIMP), which made in-situ U-Pb dating of the resilient mineral zircon possible, providing new insights into the formation and evolution of the Earth's upper crust.

Bill grew up and was educated in Perth, Western Australia (WA), where he lived with his family at their butcher shop. After his father died in 1943, the shop was sold and the family went to visit relatives in Melbourne, becoming trapped there by wartime restrictions on travel to Perth. While in Melbourne, Bill was introduced to geology by his older brother, who was stationed there in the army and had a science degree in Geology from the University of Western Australia (UWA).

After returning to WA, Bill continued his studies and in 1951 he obtained a BSc from UWA, which included Geology as one of his subjects. There, Bill met his wife Elizabeth, who was also studying geology and who became a steadfast source of support throughout his career. After a year's break, in 1953 Bill commenced PhD studies in the Department of Physics at UWA, supervised by Peter Jeffery. This was a pivotal time, as following the suggestion of Sir Marcus Oliphant from the newly established Australian National University (ANU), Jeffery was attempting, with limited resources, to complete the building of a mass spectrometer for isotope ratio studies. With the arrival of Bill and shortly afterwards several other students (including then Honours student John De Laeter), and with perseverance and much ingenuity, Jeffery and his group completed the building of Australia's first operational mass spectrometer. In 1955 Jeffery, together with his students, published the results of an extensive survey of $^{13}\text{C}/^{12}\text{C}$ ($\delta^{13}\text{C}$) ratios in fossil carbonates and coal deposits, where Bill's expertise in geology and in the new field of isotope geochemistry were already becoming evident.

Bill was thus introduced to the techniques of gas source (CO_2) mass spectrometry at the very beginning of his career, with responsibility for solving practical technical problems, such as repairing vacuum leaks and improving the electronics. Bill's PhD thesis focussed on species-level $\delta^{13}\text{C}$ studies of Permian and Devonian marine carbonates with oxygen isotope ($\delta^{18}\text{O}$) measurements from the same samples being an additional aim. Due to intrinsic technical limitations in the in-house constructed instrument, the reliability and accuracy of his $\delta^{18}\text{O}$ was in question and in 1957, Bill was awarded a Fulbright travel scholarship to the Californian Institute of Technology (Caltech) for a year. There, he continued his work on stable isotopes with Sam Epstein and was able to more accurately measure oxygen isotopes in some of his thesis samples, which provided some of the best constraints on palaeoseawater temperatures. While at Caltech, although having family responsibilities, Bill showed his dedication by finishing his thesis, with his PhD being awarded by UWA in the same year. While working in the aptly named Mudd Building at Caltech, Bill would also have been made aware of the work of Claire Patterson, who had just completed the now famous study of the "Age of the Earth" based on Pb



Fig. 1. Photograph of William Compston taken probably in 1957 for his Fulbright travel award.

isotopes in meteorites. Bill then went on to spend three months in Washington at the Carnegie Institute Department of Terrestrial Magnetism (DTM). There he was instructed by leading scientists such as Tom Aldrich and George Wetherill in isotope dilution procedures and associated mass spectrometric techniques for dating Rb-rich minerals using the Rb-Sr decay scheme.

Bill returned to UWA in 1958 as a lecturer in Physics. Supported by a small grant to Peter Jeffery from the Carnegie Institution which included a gift from DTM of a 'factory-produced' flight tube, they constructed an improved (and safer) solid source mass spectrometer. Here purified Sr samples were dried down on a rhenium filament and then thermally ionized in what is now known as a TIMS mass spectrometer. Bill led this program with the analyses of Rb rich minerals (biotite, muscovite) from local rocks. When the ages measured proved to be much younger than expected from the geology, he decided to analyse whole rocks (the first to do so), showing for the first time that minerals can gain or lose radiogenic Sr and hence give younger metamorphic ages. By contrast, whole-rocks can remain as closed isotopic systems and with a sufficient range in Rb/Sr give the 'primary' magmatic age. Using this approach, Bill was able to demonstrate the presence of ancient Archean rocks in Western Australia and to use the mineral ages to resolve the younger metamorphic events; with two letters in Nature being the result. Bill also undertook Rb-Sr dating of mica in a unique class of rocks from the Kimberley known as lamproites, be-

ing studied by Geology Professor Rex Prider. Bill showed that these intrusions were very young (145 ± 10 million years). They were subsequently found to be diamond bearing, with an unusual mantle composition.

In the early 1960s Bill was persuaded by Prof. John Jaeger to join the Department of Geophysics at the ANU. Bill was keen to take up the invitation as it represented a unique opportunity to undertake well-supported full-time research in the newly established Department, with his mother also residing in Canberra. With other members of Jeffery's group also departing UWA, geochronological work that had been pioneered in the UWA Physics Department effectively ceased. Peter Jeffery pursued his prime interest of noble gas isotope research, and John De Laeter later undertook PhD studies on tin isotopes in meteorites.

In the early 1960's Bill then set about establishing the sample processing, chemical laboratory and mass spectrometry facilities at ANU, necessary for isotope dating. Using a converted gas machine, Bill and his group undertook an Australia-wide program using Rb-Sr to date rocks, the ages of which were little known at the time. In collaboration with the Bureau of Mineral Resources, Geology and Geophysics (BMR) a second larger mass spectrometer was purchased and the geochronological program expanded. Bill, however, maintained his strong interest in improving the still relatively rudimentary mass spectrometric systems, especially for higher precision Sr isotopes as there was growing interest in determining the $^{87}\text{Sr}/^{86}\text{Sr}$ ratios of the sources of crustal rocks as well as changes in the oceans over time. He was also aware of the planned Apollo lunar sampling missions for the Moon and with PhD student Steve Clement, they designed and built a new generation higher-sensitivity TIMS, known as the MSZ. In addition to improving the ion transmission, in collaboration with Pieter Arians, rapid peak switching of the magnet and digital output to a centralized computer system was also implemented. These latter developments enabled real-time assessment of the data, with high precision and accuracy being routinely assured.

With the success of the Apollo 11 mission to the Moon in 1969, Bill was one of the few international researchers chosen by NASA to receive rocks for dating, whilst colleagues Ted Ringwood and Ross Taylor worked on related aspects of petrology and geochemistry. These mainly basaltic lunar samples posed special challenges for dating, having exceptionally low Rb contents and unlike most terrestrial rocks no obvious mineral phases with sufficiently high Rb/Sr ratios to define precise ages. Bill, however, was well prepared, having built a specialised Lunar laboratory for high purity mineral separations as well as having completed the MSZ with its high sensitivity small sample analytical capabilities. He identified a phase in the samples that he called mesostasis, the high Rb content of which improved the accuracy of the dating. Ironically many of the other more conventional Rb-Sr laboratories involved in the Lunar program failed by continuing to use the whole-rock methods that Bill had first established at UWA for granitic rocks. The exception was the Wasserburg group at Caltech who had also built a new generation of sensitive TIMS mass spectrometers as well as dedicated mineral separation facilities and clean rooms. Inevitably, there was close competition between the groups with both obtaining precise mineral ages on the Mare basalts but with a small systematic offset in ages later becoming apparent. This was resolved when John De Laeter, then a visiting Fellow at the Research School of Earth Sciences (RSES), recalibrated the Rb/Sr spikes and found only a small <1% offset. Bill's success in the Lunar program clearly distinguished ANU's RSES as the best of the international labs, giving him increased confidence in his innovative approach.

At the first lunar science conference, Bill heard that dating had also been attempted by using a small commercial ion microprobe to analyse U-Pb in-situ on a very small scale. The process was analogous to electron probe analysis but instead utilised a focused ion beam to remove material from the sample surface for isotopic analyses. The results were severely compromised, however, by the presence of mole-

cular interferences and the method was generally discounted. Working with Steve Clement, Bill decided that RSES should build an ion microprobe for geological work, but with much higher mass resolution and with the sensitivity required for trace element isotopic analyses. Modelling by Clement showed that the instrument would need to be at least three times the size of existing mass spectrometers. The undertaking was a huge risk (an expert committee advised against it), only made possible by block funding to RSES and the strong support of the then Director, Anton Hales. Clement designed the ion optics, and construction of SHRIMP began in 1974, with much of the hardware and electronics being built in-house in the RSES workshops. By 1979 the instrument was under test, by 1980 a duoplasmatron oxygen primary ion source was fitted, and in 1981 the first experiments were started, jointly with Ian Williams, dating U-Pb in zircon.

The first results were announced in the 1981 RSES Annual Report. SHRIMP revolutionised U-Pb geochronology, highlighted by the discovery by PhD student Derek Froude of >4.0 Ga zircons from the Mt Narryer sediments in WA in a sample provided by Bob Pidgeon (also a former student). This marked the start of the field of what is now known as Hadean (>4.0 Ga) geoscience with the discovery at Jack Hills, WA, of even older 4.4 Ga detrital zircons, and the dating, by Ian Williams and Samuel Bowring of >4.0 Ga zircons in igneous rocks from Canada. International visitors flocked to the lab, building links between Bill, RSES, and the leading geochronology labs throughout the world. Multiple other successes followed, chief amongst them the refinement of the geological time scale and dating of rare lunar zircons. Bill's strong ties with John De Laeter continued with the first commercially available SHRIMP II being provided to Curtin University. More recently Bill's research came full circle with the building of the SHRIMP SI which has enabled high precision in-situ measurements of oxygen isotopes in minerals. Despite the more recent development of the LA-ICPMS, the SHRIMP-type ion probe remains as the only non-destructive method for dating minerals and now $\delta^{18}\text{O}$ accurately in-situ on a 20 μm scale.

In an interview conducted by the Australian Academy of Science in 2005, Bill reflected on the unique opportunities that working at RSES had afforded to him, the importance of block funding in supporting risky scientific endeavours, and the essential support provided by the RSES mechanical and electrical workshops. SHRIMP went on to be a commercial success—the last of 21 instruments built by the ANU was installed in China in 2023.

William Compston FAA FTSE FRS died peacefully, in the presence of family members, on Friday May 16, aged 94 years.

Malcolm McCulloch

Professor Emeritus, The University of Western Australia

Ian Williams

Professor Emeritus, Australian National University

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Fig. 2. William Compston (1983) with the SHRIMP group in 1983. From right to left Prof Bill Compston, Dereck Froude (PhD student), Trevor Ireland (former Prof at RSES), Dr John Foster (Senior Technical officer – now retired), Peter Kinny (Professor at Curtin – emeritus) and Ian Williams professor RSES). Apart from John Foster all were Bill's PhD students. (Photo credit, Dave Paterson, ANU Reporter)



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