

Bhamidipati Lakshmidhara Kanakadri Somayajulu (1937–2016)

The demise of B. L. K. Somayajulu, an illustrious nuclear geochemist, brings great sadness to the community of geologists, geochemists and oceanographers in India and elsewhere. Born on 5 March 1937 in Visakhapatnam, a coastal town in Andhra Pradesh, India, Soma (he insisted that his graduate students and co-workers should call him so, a culture that was inculcated in the then Geocosmo Physics Group) got his B Sc (Honors) in Chemistry from Andhra University in 1956. He worked for two years as a Demonstrator, teaching chemistry at Mrs A.V.N. College at Visakhapatnam, prior to joining Bhabha Atomic Research Center's (BARC) Training School in Bombay (presently Mumbai). After a year's stint at BARC, Soma joined the Geophysics Group at the Tata Institute of Fundamental Research (TIFR) in Mumbai. He worked at TIFR closely with late Devendra Lal for 14 years (1959–73). When Lal moved his group from TIFR to Physical Research Laboratory (PRL) in 1972–73, Soma joined the group shortly after his return from the United States. He served as the Chairman of the Geocosmo Physics Group during 1974–75 and 1980–1982. He became a full Professor at PRL in 1983. He officially retired from PRL in 1997 and continued his active research until 2003.

Soma had participated in many international oceanographic expeditions including Nova Expedition to the Pacific Ocean (1967), several cruises to the Pacific Ocean during his tenure at Scripps Institution of Oceanography (SIO) during 1972–73. He participated in the Geochemical Ocean Sections Program (GEOSECS) – Indian Ocean Expedition during December 1977 to April 1978. The GEOSECS program was started with the first cruise in *RV Knorr* in the Atlantic Ocean starting in July 1972, followed by the Pacific Ocean Expedition during August 1973 to June 1974. Soma was actively involved as a part of this program and he ran the ^{32}Si analysis in that program (more to come later). He served as an Executive Committee Member for the International Association of the Physical Sciences of the Ocean (IAPSO) for nine years (1970–1979). He was a recipient of the prestigious Shanti Swarup Bhatnagar Award in Earth Sciences in 1978 for notable and

outstanding research contributions. He was also the recipient of Shri Hari Om Ashram Prerit Shri Chunilal Vajeram Reshamwala Trust Research Award in Oceanology in 1981. Soma was elected as a Fellow of the American Geophysical Union in 2003 and Geochemical Society in 2004. He was also an elected fellow of the Indian Academy of Sciences (Bengaluru) and Indian National Science Academy (New Delhi).

The early sixties through seventies was a golden era in the field of isotope geochemistry where novel and innovative applications of radioactive isotopes constantly emerged, similar to the Golden era of 1905–1930 for physics. Soma visited the Scripps Institution of Oceanography (SIO) in La Jolla, California, USA as a Research Associate from 1964 to 1967, during which he was working on problems in marine geochemistry, in particular measurements of uranium and thorium in seawater and sediments¹, dating of sediment cores², U-series disequilibrium in basalt³ and beryllium-10 in manganese nodules⁴. These studies were subsequently pursued by a large number of research groups around the world. During his stay at Scripps during 1964–1967, he met many graduate students, some of whom became his life-long friends that include Tom Church (who used to call Soma as his brother) at University of Delaware, Newark, USA and Roy Carpenter at University of Washington, Seattle, USA. Soma had the unique 'bragging right' of working with two prominent geochemists, Ed Goldberg and Harmon Craig and had published papers with them together. This was a very unique feat (some knew these two very strong personalities and the politics between them while both worked in the same division at Scripps).

The detection of ^{32}Si was first made by Devendra Lal and his associates⁵ in 1960. The group under the tutelage of Lal developed and perfected an in-situ extraction method in which large volume (10,000–100,000 litres) of seawater was allowed to flow freely through natural sponges coated with ferric-hydroxide. Soma developed the methodology for the measurement of cosmic-ray produced ^{32}Si , an isotope whose reported half-life kept changing over the past 50 years ($T_{1/2} \sim 500$ years⁶, ~ 300 – 600 years⁷,

172 ± 12 years⁸, 144 ± 11 years⁹). The most recent value of 144 years is approximately less than 1/3 of the original value, yet with an uncertainty of at least 10% of its current value. He was instrumental in developing the low background $4-\pi$ home-made beta counting system (almost every one of Lal's graduate students in those days was required to build a very low-background beta counter, as a part of their training) to measure the beta particle emitted by the progeny of ^{32}Si , viz. ^{32}P ($\beta_{\text{max}} = 1.709$ MeV, half-life: 14.3 days). As a part of the GEOSECS program, large volume (10,000–100,000 litres) water samples were analysed and the results were published with Soma as the first author in all three publications^{7,10,11} covering all three major world oceans. At the time, when the quality of published ^{32}Si data was questioned by a small group of prominent geochemists, a rigorous scrutiny of the published results resulted in proposing a new mechanism, viz. role of mixing of two sources of silica trapped by the collecting fibers⁷ to explain the anomaly between the expected and measured values of silicon in the deep oceans^{12,13}, a testament to the high-quality of ^{32}Si data by Soma and his associates. Thus, the ^{32}Si analytical work was completely tested, developed and executed in the world oceans by the Indian group.

The second major work that Soma conducted was on the ^{10}Be dating of manganese nodules. The half-life of ^{10}Be was considered to be well-known over a period of four decades, 1.5 Ma, although individually precise, but differed by approximately 10%. The rapid expansion of



The then Chief Minister of Gujarat, Mr Chimanbhai Patel (left), and the then Prime Minister, Mrs Indira Gandhi (middle) discussing with Prof. B. L. K. Somayajulu (right) at PRL Open House on the Occasion of PRL Silver Jubilee, 1973.



Prof. B. L. K. Soamayajulu receiving an award at PRL Ramanathan Auditorium.

the utility of ^{10}Be as a tracer for exposure dating of surfaces that are very young with respect to the ^{10}Be half-life required precise value and in the last 10 years, the value is revised to 1.387 (± 0.012) Ma (ref. 14). Soma showed that the accretion rate of the polymetallic nodules is 1–2 mm per million year for the first time using ^{10}Be which agreed with other methods employed at that time. He subsequently continued this work with deep-sea sediments for the determination of sediment accumulation rates.

In addition, Soma worked on many different research problems including: (i) $^{210}\text{Pb}/^{226}\text{Ra}$ disequilibrium in deep ocean, showing the residence time of ^{210}Pb of about 50 years which was conducted jointly with Harmon Craig of SIO. This work has enormous implications on the residence time of other particle-reactive substances such as ^{230}Th , ^{228}Th , ^{231}Pb , ^{210}Po , ^{10}Be , etc., in the deep ocean. Furthermore, the $^{210}\text{Po}/^{210}\text{Pb}$ and $^{210}\text{Pb}/^{226}\text{Ra}$ disequilibrium study is being carried out by the currently ongoing international GEOTRACES Program (<http://www.geotraces.org>). (ii) Soma, in collaboration with others, had shown that ocean sediment cores can be logged for their variations in magnetic susceptibility with depth and that these studies have great importance in understanding volcanic and other events in the past. (iii) Investigations on the uranium input from Indian rivers to the oceans and investigations on the geochemical behaviour of uranium in

estuarine and coastal areas. (iv) Age and origin of Quaternary carbonate deposits, known as ‘Miliolites’ (proposed by Carter in 1849 as he found a large number of foraminifer belonging to the genus *Miliolina*) and his work with his student established the first chronological framework and a quantitative assessment of its origin (whether marine or aeolian). (v) Water mass mixing using radium isotopes in the Bay of Bengal. (vi) ^{14}C studies for vertical mixing of water masses and CO_2 air–sea exchange rates in the Arabian Sea. (vii) Sediment deposition rates in the continental margins of the Arabian Sea, etc.

Soma’s contribution to Indian science is significant as evidenced by the AGU citation when he was elected to the Fellowship of the American Geophysical Union which states: ‘... for establishing a school of nuclear-oriented geochemists and oceanographers in India’. He always motivated his graduate students to work hard and pursue the research profession as their career with passion and he used to compare the hard work of a researcher to the sweat and dedication of a soccer player in the World Cup.

After his official retirement in 1997 at the age of 60, Soma continued to work as a CSIR Honorary Professor and kept-up his usual vigour and thirst for science. One of the present authors (M.B.) had the privilege of spending a couple of days with him in Detroit, Michigan during his North America trip in 2002 (after spending 7 years as a graduate student–postdoc during 1980–1987) on the way to participate on a cruise starting from Brazil (at the age of 65!). He met with an unfortunate motor cycle accident in Ahmedabad that resulted in a head injury in spring 2003 which caused a partial memory loss. Those of us who knew him well can testify that he would have continued his active research at least for another 10 years if not more, had that accident not happened. Soma is survived by his wife, his son and his married daughter and a grandchild.

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