Samuel Warren Carey

Campbelltown, November 1, 1911 – Hobart, March 20, 2002

Commemorative memoir

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Fig.1
Samuel Warren Carey.

During the editorial process of this book, Emeritus Professor Samuel Warren Carey passed away on 20 March 2002 at age 90. He was born at Campbelltown, New South Wales on 1st November 1911, and attended school at the Canterbury Boys High School. Carey's father was a printer, who became a public lecturer when he arrived in Australia. His mother's people were early Australian settlers. The Carey home was a farm near Campbelltown and as a boy, little Samuel walked nearly seven miles to School and back each day, an activity that prepared him for work in harsh climatic and environmental conditions. Sam Carey's large family included two sisters and four brothers, one of whom died in World War II.

At the University of Sydney, in 1929, Carey enrolled in chemistry, physics, and mathematics and only as a fourth subject – geology. However, he was soon reoriented towards geology as his main subject by Sir Edgeworth David, an Antarctic explorer. This preference developed from his liking for fieldwork in geology, combined with lab work. He was strongly inclined towards sports (hockey, sailing, rugby, marksmanship, canoeing) and physical activities (cave exploration, rock climbing, hiking, jungle expeditions, parachuting).

He graduated in Geology from the University of Sydney earning a Bachelor of Science with First Class Honours in 1933, Master of Science in 1934, and Doctor of Science in 1939. At university he founded the Student's Geological Society in 1931 and was its first president.

He has been a pioneer in geology all his life. He was fortunate to participate as a protagonist for two and possibly three revolutions in the Earth sciences. He challenged the concept of continents in fixed positions from the outset and from 1946 to 1956 he taught a version of intercontinental movement with subduction in deep ocean trenches. This came to be called 'plate tectonics' some twenty years later but at the time when no one believed in any form of intercontinental movement, Carey's version was also called 'continental drift' by default. 'Continental Drift' had been proposed by Wegener (1915) and largely discarded in 1926 for

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Why expanding Earth? – A book in honour of O.C. Hilgenberg. INGV, Rome, 85-95.

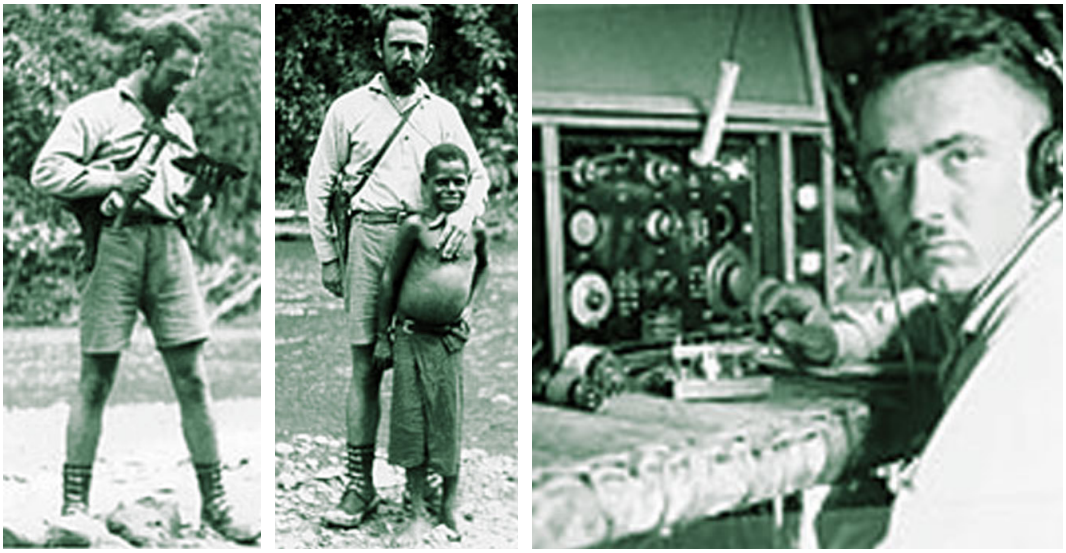

Fig. 2
Carey in the years of his expedition in New Guinea.

failure to identify any mechanism that would cause intercontinental movement at constant Earth radius. Carey resolved this by proposing an expanding Earth in 1956 and finally went on to identify a possible mechanism for Earth expansion in 1976.

After his university degree at the University of Sydney Carey joined Oil Search, and then the Australasian Petroleum Company. He worked from 1934 to 1942 as a petroleum geologist in New Guinea, entering many unexplored areas, and showing a marked aptitude for recognising all the geological details that make exploration economically successful. He was the only white man during the exploration that was conducted on foot along rivers, and in canoes and rafts. He was the first to introduce metals to many New Guinea natives. On one occasion hostile natives ambushed the expedition and some of them were shot. A magisterial enquiry in 1937 completely exonerated Carey on the grounds of necessary self-defence.

Carey completed his DSc during the years he worked in New Guinea. He submitted his dissertation on the *Tectonic evolution of New Guinea and Melanesia* in 1939. The examiner was a Dutchman who had worked all his life in New Guinea and in Timor. However, sending this thesis from Australia to the examiner became an eventful saga due to difficult communications during the war and continuous movement of the examiner to localities in Europe and Indonesia. His thesis went literally around the world by sea-mail following and never quite reaching the travelling Dutchman until the long delay convinced Carey that he had failed! But this was not the case. Finally the thesis was discussed and he was awarded his DSc. At this time Carey came to recognise the importance of an interdisciplinary approach to global Earth movements. The possibility of intercontinental movement and

reasons for the rejection of earlier hypotheses to this effect became a topic of major interest to him.

Sam Carey and Austral Robson were married in June 1940. After his marriage, Carey then served in the War from 1942 to 1944. He led a special crack force, the paratroops Z-unit, behind Japanese lines. He showed incisive intellect and bravery in the face of many risky situations. When he returned to Australia he was employed at Port Moresby in the training of personnel destined to work behind enemy lines, and he also ran cave training courses for commandos. Carey developed improvements to canoes and paddles for commando work.

At the end of the war he was appointed Chief Government Geologist at the Department of Mines in Tasmania and to the University of Tasmania's Faculty of Science as an external member. In 1946 he became Foundation Professor of the Department of Geology at the University of Tasmania. The Department achieved a high international standing under his guidance as Professor and Dean of the Faculty of Science. He gave special attention to establishing and maintaining durable links between the University and the Geological Survey, the Hydroelectric Commission, and the mining and other industries. This was an advantage for the development of both regional economic prosperity and for professional consulting opportunities for new graduates. The Tasmanian Seismic Network was installed in 1957 under his direction in cooperation with the Hydroelectric Commission and in 1960 the net in operation became one of the most advanced seismic networks in the world. Carey's interest in mapping and interpreting important tectonic structures were a decisive influence in Australia taking a political decision to become at least partially independent in relation to hydrocarbon resources.

Carey's instruction was dramatic and unforgettable. His lectures were filled with students often packed in all available space to follow his inspiring talks. Most of them admitted the strong influence of Carey's style of thought in their scientific development. It was well remembered that not even heavy rain would stop him from leading and teaching on geological excursions. Students made their notes and sketches on sopping wet notebooks. Many of his students have had significant international careers and fourteen Professors of Geology have graduated from Carey's classes and the Department he founded.

Carey was involved in contesting the opinion of Jeffreys concerning a misfit between the continental shapes of Africa and South America, and consequently that reconstruction of the supercontinent Pangea might completely lack significance. Carey built a large wooden hemisphere to the shape of the globe, and using spherical sheets of transparent film he avoided subtle and unwanted cartographic distortions. He demonstrated a good fit of the two continental shapes and pre-Paleozoic correspondence of

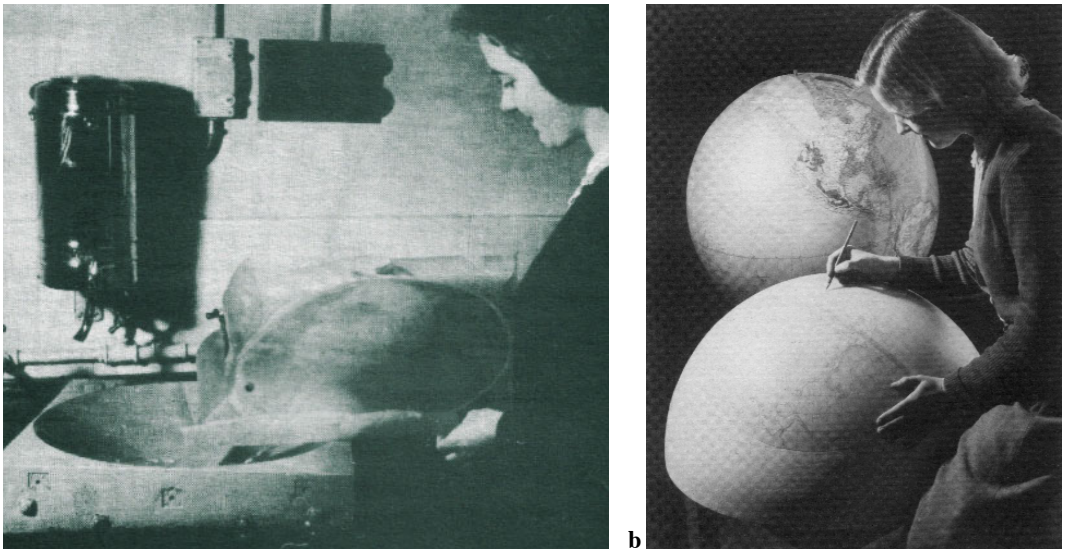

Fig. 3 a,b,c,d
Carey's Atlantic fit.

a - the mould for the spherical sheet of film.

b - the table on which the continental shapes on moulded film were fitted.

c - the close Atlantic fit using the 2000 m. isobath.

d - the less perfect fit using the shallow 200 m. isobath.

geological and geophysical trends in the rejoined coastlines. He abandoned teaching 'plate tectonics' concepts and taught 'Earth expansion' from 1956. His results were first published in 1955 in *Geological Magazine* (vol.92, page 196) and full details in *The Tectonic Approach to Continental Drift* (Continental Drift, A Symposium, Geology Department, University of Tasmania, 1958). Only ten years later, in 1965, the task of examining the intercontinental fit was repeated – by using the first computers – in the 'Atlantic fit' of Bullard, Everett and Smith.

In 1953 the first subduction model (today admitted by advocates of plate tectonics) was submitted by Carey for publication to the *Journal of Geophysical Research*. It was rejected because it was judged 'naive and unsuitable for publication' by referees. The passage from Wegener's drift, without subduction, to a new concept of crustal balance was first due to him. The geological community today uses many of his concepts. The definitions of orocline, sphenochasm, rhombochasm, megashear, *etc*. that have been accepted and discussed internationally are especially well known.

Carey developed a new way to interpret orogens. He did not ascribe the building of mountain chains to compression – as is commonly accepted by the geological community involved in contraction or pulsation tectonics. Carey ascribed it to isostatic instability where rising mantle beneath deep sediment filled trenches causes diapiric uplift. The observed folding was explained as the consequent downward gravitational sliding of uplifted strata. This mountain building concept is still considered valid today and it constitutes part of a more diversified classification of mountain evolution that has been developed by Cliff Ollier.

Carey organised a series of international symposia (Glacial Sedimentation, 1955; Continental Drift, 1956; Genesis of the

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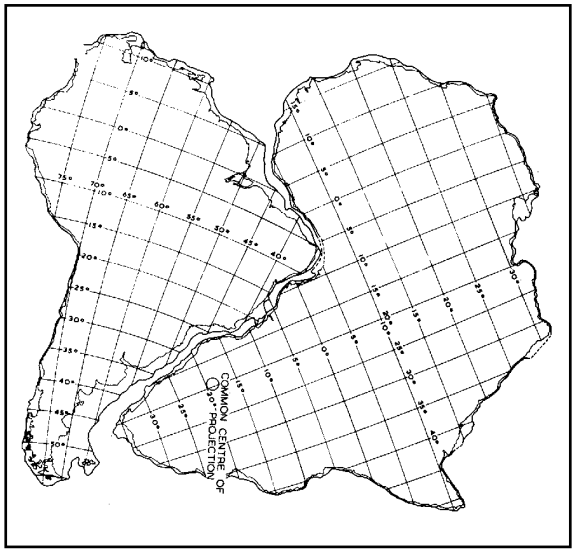

d

Lyell Schist, 1956; Dolerite, 1957; Syntaphral Tectonics, 1963; and The Expanding Earth, 1981). The subjects were always at the centre of heated geological debate. The best known of these was the Continental Drift Symposium of 1956 that has now featured in many textbooks of the history of science. It was during this Symposium that Carey proposed abandonment of the subduction concept (there was no known mechanism for intercontinental movement and it defied isostacy), and put forward step by step the concept of Earth expansion. A significant section in his long book within-a-book contribution to the proceedings (p.177-355) was devoted to the expansion hypothesis (p.311-349). Carey – using the orocline concept – generalised his views on movement between continents, demonstrating that the continents could fit together better if the Earth was smaller in size.

Carey frankly admitted belated inheritance of some Egyed and Hilgenberg ideas. He did not know about Hilgenberg's book *Vom wachsenden Erdball* before the 1956 symposium. This book arrived in 1958 when the proceedings were being printed. He found a page to show and quote the German series of paleogeographical globes and a photo from Hilgenberg, 1933, is reproduced on p.300 of the proceedings. Later Carey studied Hilgenberg's work in depth and confessed to me that he had learned the German language for this purpose.

The sabbatical year 1959-60 was very important in Carey's scientific career. He spent it at Yale University as Distinguished Visiting lecturer at the suggestion of Chester Longwell. Longwell was very impressed with Carey's work when Sam invited him to write the introduction and epilogue of the Continental Drift Symposium proceedings. Longwell thought expansion tectonics was a radical and also a shocking concept – in a geologist com-

munity accustomed to the idea of a contracting planet – however, with the promise of new developments. Carey's stay in Yale coincided with dissemination of the first information about ocean floor geophysical surveys. Based on this his charismatic and incisive talks contributed to convincing geoscientists of the validity of intercontinental movement prepared the way for the development of mobilistic ideas. The geologist John Rogers recalled that North American geology has never been the same since! At this time all Carey's family, Sam, Austral and four teenagers, spent a year in the USA, Canada, the UK, and Europe with Sam at Yale and on lecture tours. This resulted in a number of overseas students coming to Hobart for further studies.

Extended work on the expanding Earth was published in an essay-review (Carey 1975) and a year later the famous book *The Expanding Earth* (Carey 1976) came out. He retired as Professor of Geology in 1976 but continued his investigations of the more general cosmological implications of the expanding Earth (Carey 1988, 1991, 1996). He took advantage of his initial interest in physics and mathematics. The universe was depicted as a balancing of different forms of energy – mass and potential gravitational energy. The universe was envisaged as an entity still developing with new energ y emplaced as mass in the interior of the planets balanced by removal of matter as receding galaxies attained the speed of light in relation to any other galaxy within its 'knowable' universe. Carey introduced a concept called the null universe – a universe derived from a necessary balance of energy with matter. The fundamental merit of Carey's work is that he has been able to defend the expansion model against all attempts to logically invalidate and refute it. The Earth expansion model today stands unchallenged as scientifically valid.

Carey was made an Officer of the Order of Australia in 1977 and became a Fellow of the Australian Academy of Science in 1989. The reason for this late admittance to the Academy is a long story of misunderstanding due to strong scientific conservatism among Academy Fellows. It is sufficient to say that in 1954 he was denied automatic transition from a member of the Australian National Research Council to Academy Fellow (Sam had been a member since 1938) because it was believed he advocated continental drift. In reality at that time Carey taught and advocated sea floor spreading with subduction as a necessary consequence. Members of the Academy misunderstood his teaching of the concepts that were much later called 'plate tectonics' for the discredited 'continental drift' ideas of Wegener. 'Continental drift' was the only name for any intercontinental movement at that time. The situation deteriorated completely when three referees of the Academy rejected a paper by Carey on the Orocline concept. Later this became appreciated world-wide as a classic and correct geological concept.

From 1976 on, he dedicated his life to the promotion of new frontiers of geological science in Australia and around the world. On the occasion of one of his long trips in 1984 Carey stopped in Italy on my invitation to deliver a public lecture at the Geology Institute of Rome University. In the following year he attended a geological meeting convened by Forese Carlo Wezel at the University of Urbino, where he was awarded the *Onoris Causa Laurea*. An essay-book *La Terra in Espansione* was planned and printed in Italy in 1986. Its English manuscript was the basis for the more extended book *Theories of the Earth and Universe* that was published by Stanford University Press in 1988 and is known world-wide.

My contact with frontiers of science in Australia was maintained with a month of study and research in Hobart at the University of Tasmania where I enjoyed the wonderful hospitality of Sam and Austral Carey. Austral was initially a trained nurse – she gave birth to four children in rapid succession – but in the 1960's she studied for a Fine Arts Diploma at the Hobart Art School, that is now located in the University. The Careys loved to attend public art exhibitions and I, too – as an amateur painter and etcher – was delighted to accompany them on some of these occasions. Many items of scientific or historic interest that I obtained or become aware of during that visit have been revised and used in my recent works. I had my first text of the 1933 Hilgenberg book recopied from Carey's photocopies where nearly half the original German text was placed side by side with Carey's typewritten English translation. For me this was much more understandable. I also obtained a copy of an instructive old publication by Samuel Carey about the Tasmanian Seismic Network. This contains a very long folded figure like a cartoon representing the step by step propagation of all types of seismic waves – P waves, S waves, Raleigh waves, etc. – across the Earth's spherical section. Following Carey's detailed sketch, it had been my wish for many years to have a truly interesting and instructive cartoon that could be projected during visits to my Institute of high school classes or students. Two years ago when I was about to have some computer graphics experts work on the idea, I was pleased to find that Carey's wave propagation sequence had been assembled and illustrated just a few months earlier by Alan Jones (IRIS Consortium web site and *http: //www.geol. binghamton.edu/faculty/jones*). It has now become an integral part of the instructive material projected to students and teachers visiting INGV.

My stay in Hobart in 1987 occurred at a time when the plate tectonics model was regarded as successful and widely accepted. I therefore felt the atmosphere of intellectual isolation endured by Carey as a retired professor. This came especially from the young staff of the Geology Department at his university. Carey had been

given a little room and desk beside the room of another famous old scientist, the geophysicist W.D. Parkinson. Samuel Carey was considered a pioneer, a milestone, a great old man, with a bronze bust already prepared for placement after his death, but the most of the young researchers had uncritically followed the main stream – the *bandwagon* – as Carey called it!

They worked intensively on plate tectonics research. Younger researchers in Carey's Department were active in world-wide field surveys of oceanography and in Antarctic science, in a very positive and rather resourceful original spirit. This same spirit of independence has prevented most anonymous Australian obituary writers from citing the critical step forward in geological science that Carey has made in their tribute. For many of them the Expanding Earth concept is still a disquieting idea.

However, at least something in the educational program of the Australian Academy of Science has changed positively. I have been able to buy an excellent comprehensive textbook of geology prepared for high schools and basic university courses by Clark and Cook. It contains a chapter entirely devoted to the expanding Earth hypothesis. This book was printed in 1983 by the Academy, and perhaps among other things, it was an element that influenced Sam Carey's decision to renounce his belligerency and accept the Academy's offer to become a Fellow. Carey's last years were dedicated to the production of new books. One of these – *Earth, Universe, Cosmos* – was printed by the University of Tasmania in 1996 on the occasion of the Fiftieth Anniversary of the Geology Department. The book is an inquest into our creeds dedicated *To my students*.

I am honoured to say that the influence of Carey's thought has been of fundamental importance to my own work on global expansion tectonics, and my hope is that a further spreading of this influence could interest new generations of geoscientists. Many new things can be seen on our planet by simply adopting a new point of view, and Carey's exhortation to his colleagues and students was '*We are blinded by what we think we know, therefore disbelieve if you can!*'

A giant of geology has left us, a man whose thoughts were always ahead of his time. He died at a Hobart private hospital after several months of poor health.

A Carey memorial gathering was organised by CODES (Centre for Ore Deposit Research) in the Earth Science building at the University of Tasmania on Sunday 16 June 2002, and about 80 of his colleagues and former students assembled to hear talks about his life and works. Among them were Paul St. John (*Carey's role in tectonic theory*), Pat Quilty (*Carey the man*), David Leaman (*Carey down to Earth*), Max Banks (*Carey and the Department*), John Elliston (*Carey's challenges to orthodoxy*), David Groves (*Anecdotes from undergraduates*).

Fig. 4
Austral and Sam Carey few years ago.

An unusually intense earthquake (magnitude 4.4) was felt at 1.15 a.m. in Tasmania on the same day as the memorial gathering. Aftershocks were still being recorded on the large seismograph in the front hall at the entrance to the Geology Department when guests were arriving. From comments made among the friends, colleagues and former students of the late Professor Samuel Warren Carey it was noted that 'his spirit is still with us' and the Earth might indeed be expanding!

His wife Austral, four children Tegwen, Harley, Robyn, David, and seven grandchildren Krista, Samuel, Warren, Sarah, Eleanor, Sean, Geoffrey, and two great-grandchildren Caitlin and Phoebe survive him.

Honours and decorations

The following is only a partial list of the more important honours and decorations conferred on Samuel Warren Carey:

Professor Carey served as President of the Geological Society of Australia, President of the Australian and New Zealand Association for the Advancement of Science, and as chairman of the School Board of Tasmania. He was also Chairman of Trustees of the Tasmanian Museum and Art Gallery, and Chairman of the Professorial Board of the University of Tasmania.

He was an Honorary Life Fellow of the Geological Society of Australia, the Royal Society of New South Wales, the Geological Society of London, the Geological Society of America, the Australian and New Zealand Association for the Advancement of Science, and the Indian National Science Academy. He was a Fellow of the Australian Academy of Science and an Officer of the Order of Australia.

He received Honorary Doctorates from the Universities of Papua-New Guinea and of Urbino (Italy).

He has been awarded the Clarke Medal of the Royal Society of New South Wales, the Johnston Medal of the Royal Society of Tasmania, and the Browne Medal of the Geological Society of Australia. Other awards include the Gondwanaland Gold Medal of the Mining, Metallurgical and Geological Society of India, and the Weeks Gold Medal of the Australian Petroleum Production and Exploration Association.

Acknowledgments

Special thanks to Austral Robson Carey for the invaluable manuscript and printed materials that have provided the basis for this paper in Carey's memory.

Thanks to an unexpected e-mail and a text sent in September 2002 by John Elliston this obituary has been improved and the historical section of this book has been enhanced.

Selected essays and books of S.W. Carey

1958: The tectonic approach to continental drift. In: S. W. Carey (ed.): *Continental Drift – A Symposium*. University of Tasmania, Hobart, 177-363 (expanding Earth from p. 311 to p. 349).

1975: The Expanding Earth – An essay review. *Earth Science Reviews*, 11 (2), 105-143.

1976: *The Expanding Earth*. Elsevier, Amsterdam, pp. 488.

1981: The Expanding Earth – A Symposium (Proceedings). Earth Resource Foundation, Edgeworth David Building, University of Sydney, February 10-14, pp. 423.

1986: *La Terra in Espansione* (in Italian). Laterza, Bari-Roma, pp. 346.

1988: *Theories of the Earth and Universe – A history of Dogma in the Earth Sciences*. Stanford University Press, 1988, Stanford, California, pp. 413.

1991: *B Poiska Zakonomernostei razbitiya Zemli I Bselennoi* (in Russian). Mir, Moscow, pp. 447.

1996 & 2000: *Earth, Universe, Cosmos*. University of Tasmania, Hobart, pp. 258.

References

Anonymous, 2002: Professor Samuel Warren Carey (1911-2002). *Unitas – News from the University of Tasmania*, vol. 221 (4 April), 4-4.

Anonymous, 2002. Vale Professor S. Warren Carey (first page article). *Ore Solutions Newsletter*, CODES, University of Tasmania, n. 12 (May), 1-1.

Anonymous, 2002. Professor S. Warren Carey AO (obituary). *Ore Solutions Newsletter*, CODES, University of Tasmania, n. 12 (May), 2-3.

Burchfield, BC., and Powell, C., 2001: GSA Structural Geology and Tectonic, Division 2000 Career Contribution Award to SW Carey. *Str. Geology and Tectonics Div. Newsletter*, 20 (1), 6-7.

Elliston, J., 2002. Personal communication on some aspects of Carey's life.

Large, R.R., 2002. A Tribute to Professor S. Warren Carey (funeral oration). *Ore Solutions Newsletter*, CODES, University of Tasmania, n.12 (May), 3 -3.

Quilty, P., 2000: Interview with Professor Sam Carey (1911-2002). *Australian Academy of Science – Science education*. Web-site.

Robson-Carey, Austral, 2002. Personal communications, curricula, short autobiographical notes.

Scalera, G., 1986. Postfaction to Carey's book *La Terra in Espansione* (in Italian). Laterza, Bari, 305-309.

Thow, P., 2002: Shock sign for Carey's send-off. *The Mercury*, Monday, June 17, 2-2.

Wezel, F.-C., 1986: Preface to Carey's book *La Terra in Espansione* (in Italian). Laterza, Bari, vii-xxiii.