The Chronologers' Quest

Episodes in the Search for the Age of the Earth

The debate over the age of the Earth has been going on for at least two thousand years, and has pitted astronomers against biologists, religious philosophers against geologists. *The Chronologers' Quest* tells the fascinating story of our attempts to determine a true age for our planet.

This book investigates the many methods used in the search: the biblical chronologies examined by James Ussher and John Lightfoot; the estimates of cooling times made by the Comte de Buffon and Lord Kelvin; and the more recent investigations of Arthur Holmes and Clair Patterson into radioactive dating of rocks and meteorites.

The Chronologers' Quest is a readable account of the measurement of geological time. Little scientific background is assumed, and the book will be of interest to lay readers and earth scientists alike.

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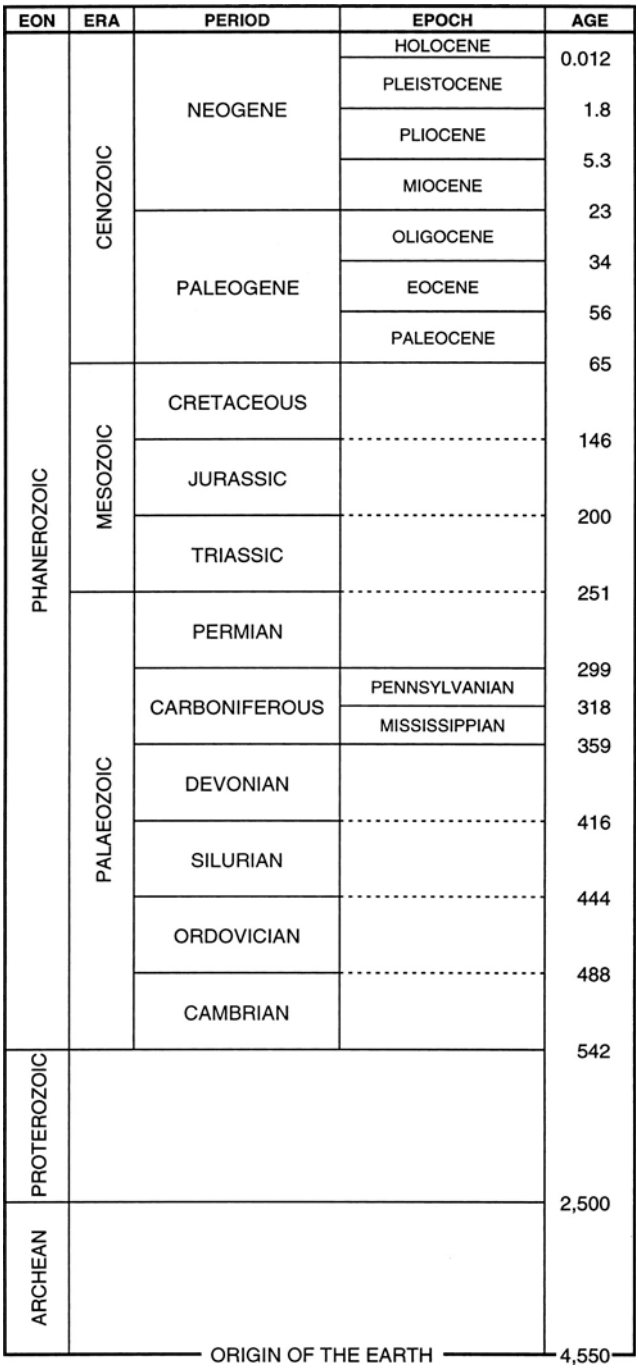

The Geological Column with the age in millions of years of the start of each major stratigraphical unit (simplified and modified from the International Stratigraphic Chart published in *Episodes* 27, part 2 (2004), 85).

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To Vanessa in Dublin, and Marcus and Eric
in Carlisle, Pennsylvania

Contents

Illustrations

Tables

Preface

> Geologists have been much censured
> for vainly endeavouring to assign measures of time
> to the seemingly vague and shadowy ages
> of the Trilobites and Belemnites.

John Phillips (1800–1874), *Life on the Earth, its Origin and Succession* (1860)

> Some drill and bore
> The solid earth and from the strata there
> Extract a register, by which we learn
> That He who made it and reveal'd its date
> To Moses, was mistaken in its age.

William Cowper (1731–1800), *The Task* (1785)

I have two main reasons for writing this book, and both have their origins in family matters. A few years ago I spent a fortnight with my wife and two young daughters on holiday on the Dingle Peninsula, in southwest Ireland. This area of immense scenic beauty and cultural significance is also an area of 'classic' geology. As an undergraduate student I had followed in the footsteps of geologists such as George Victor Du Noyer, a noted antiquarian and watercolourist, and Joseph Beete Juke, his boss in the Geological Survey of Ireland, in mapping some Silurian and Devonian sediments that formed the backbone of the peninsula. I doubt I produced a fuller and more accurate map than did these early pioneers. I recalled with feeling, during the first three damp, rain-sodden days of our holiday, the remark of Sir Roderick Impey Murchison, one-time Director of the Geological Survey of Great Britain, who declared, having endured two weeks of such weather, that 'there was nothing of interest in Irish geology'.

However, the changing weather conditions, allied with the splendid sunsets that we witnessed during the first week of our holiday, clearly left its mark on my elder daughter. She saw beautiful salmon-pink clouds streaking across the Kerry sky, which reflected

the favourite culinary dish of my wife. She heard about the unusual 'green flash' that occasionally accompanied the very last vestiges of the orange sphere as it disappeared beneath the distant horizon – but was not fortunate enough to see it. This daily cycle of dawn, morning, afternoon and sunset got her thinking, and out of the blue as we crossed the mountainous road of the Connor Pass, a little voice from the back of the car asked, 'Mummy, how long ago did the world begin?' Quickly, realising my interest in the subject, my wife deflected the question to me.

'How long ago did the world begin?', I thought, pausing to reflect on the complexity and indeed simplicity of such a question from a person who had only celebrated her fifth birthday a month earlier. If I had attempted to fob her off with a response such as 'Oh, a long time ago' or 'Well, sometime before Granny was born', I knew that this would have been most unsatisfactory from the perspectives of both Susanna and myself. 'The world is over four thousand million years old,' I replied as I turned around. 'That's a lot of noughts, isn't it,' she thought out loud. And she was right, it is a lot. For a few moments she took this in, and appreciated that the world was very old indeed.

On my return to the city, I met up with my youngest brother Michael for our usual weekly lunchtime escape from respective offices and he handed me two items. One was a book and the other a large roll of paper. He was aware that I was beginning this book, and said, 'You're interested in James Ussher. Have a look at these.' The book was a small green octavo volume entitled *The Life and Times of Archbishop Ussher*, written by a Reverend J. A. Carr, Rector of Whitechurch, a small parish situated four miles south of Dublin that nestles on the northern slopes of the local granitic mountains. He had found it on a upper shelf in a bookcase in my mother's house, and I was delighted that he had, as I had been trying to track down a copy of Carr's book, perhaps the best and most accessible biographical treatment of the Archbishop published in the nineteenth century. The second item, the large roll of paper, proved to be of great personal interest, but unfortunately of less use to me here. I carefully unrolled

the four-foot-long document on the table and saw it was a family tree. Right at the top was written 'Henry Jones = Margaret Ussher (sister of the Primate)'. I gazed at the multitude of names and dates, interconnected by a maze of straight and wavy lines, and passed my eyes over several generations. Another Henry Jones listed was Bishop of Meath between 1661 and 1682 and was responsible for rescuing the Book of Kells, the seventh century version of the Gospels, from a bog in County Meath. This, the finest of Irish illuminated manuscripts, is on show in the Library of Trinity College Dublin, where it is seen by nearly a million tourists each year. Another character by the splendid name of Rashleigh Belcher caught my eye. He was a medical doctor who practised in the market town of Bandon in County Cork. I finally made my way down to the bottom of the document and there in plain black ink was my name. Amazed, I turned to my brother and remarked, 'We're related by marriage to James Ussher!' and added with a laugh, 'Mum's family is quite interesting after all, but it's a pity that they didn't hang on to the Book of Kells!' Buoyed up by this unexpected piece of genealogical coincidence, I returned home, turned on the computer and began to type.

Like my daughter, so many others have pondered the age of living organisms and also of the Earth. Biologists can examine the ontogeny of an organism for an indication of its age. As growth proceeds, the individual or colonial organism undergoes change. We are all aware of the stark changes in humans that distinguish infants from pre-pubescent children, and adolescents from fully grown adults. With adulthood these changes become less perceptible, but occur nevertheless. Hair colour changes, hair loss in many males increases, ears in men often become larger, and so on. In humans, it is easy to determine the age of an individual simply by asking, although this may still draw a blank. It is perhaps somewhat indelicate to ask the elderly their age. If they refuse to answer, or worse still cannot remember, one can raid the desk bureau and pull out the folded and faded birth certificate that will supply the answer. Although similar certificates might supply the information on the age of thoroughbred horses

or of Cruft's champions, such certificates do not exist for most of the living organisms on Earth, nor for the inanimate Earth itself. For these we have to rely on other chronological indicators.

The early twentieth-century English microvertebrate palaeontologist W. C. Swinton was interested in Eocene fish, and conducted a careful study of the bones found in their ears. These otoliths are the shape of dinner plates, but much smaller. What he found was that they appeared to be composed of skeleton deposited in concentrically arranged patterns. He showed that these rings could be used to accurately age a fish. Similarly, the horsemen of the Tashkent plains or the wet fields around Ballinasloe in the west of Ireland can tell the age of a prospective purchase by looking into the horse's mouth and examining the condition of its teeth. They can rapidly tell if a horse claimed to be a three-year-old is rather longer in the tooth than that, and consequently worth much less. The age of trees is widely determined by ring counting, and this science of dendrochronology has proved to be a valuable resource in the study of past climates and an indicator of possible future climate changes.

But the Earth has no ears containing otoliths, nor does it have teeth or annual rings. It presents a complex array of indicators which philosophers, scientists and men of the cloth over at least two millennia have examined to answer the question: how old is the Earth?

This book presents the fascinating story of our attempts to determine the age of the Earth on which we all live. Since earliest times we have attempted to understand the nature of the Earth and its formation. Estimates of its antiquity have varied considerably from low biblically derived timescales to recently derived higher ages based on meteorites. Many novel methods have been pressed into service. Researchers have examined the biblical chronologies, the cooling rate of the Earth, rates of erosion and the thickness of sedimentary rocks, the saltiness of the oceans, the radioactivity of the rocks, and the constituents of the Moon and meteorites. All have been important steps in the evolution of this theme, and have contributed to our present understanding of the Earth.

The debate that has been going on for over two thousand years has pitted various protagonists against each other: biblical versus non-biblical chronologers; physicists versus geologists; and more recently scientists versus creationists. At the turn of this present century a consensus has been reached amongst the scientific community and the majority of the general public that the Earth is four and a half thousand million years old.

Can we style these geological and biblical investigators 'chronologers' as I have done in the title of this book? Yes, I believe that it is perfectly acceptable to do so. According to the *Oxford English Dictionary* a chronologer is one versed in chronology; 'One who studies chronology, one who investigates the date and order in time of events' – in this case, the date of the origin of the Earth.

This book examines a number of episodes in the debate, starting with the ideas of some ancient civilisations and finishing with the present state of our understanding of this concept. It does not set out to produce new research facts; rather it brings together the strands of diverse research in geology, astronomy and religious chronology and aims to make the whole story of the dating of the Earth available to a new body of readers not conversant with the scientific literature.

Acknowledgements

I owe a great debt of gratitude to two Fellows Emeriti of Trinity College Dublin, both of whom taught me during my undergraduate years, and both of whom became colleagues once I joined the staff of the college. Gordon Herries Davies is a historian of geology and geomorphology whose writings and lectures captivated and inspired me to embark on studies in his field. He gave me early guidance and huge encouragement when I dipped my toe into the subject and later nominated me for membership of INHIGEO (the International Commission on the History of Geological Sciences). Through this group I have made many friends throughout the world. A number of years ago I was delighted to host a group of INHIGEO colleagues on an excursion around Ireland when we examined those sites of significance to historians of geology such as the Giant's Causeway, and on the second last day, Gordon, together with Jean Archer, interpreted for us the unusual features of the Blackwater Valley. Charles Hepworth Holland was both my teacher and my boss. A stratigrapher and cephalopodologist who focuses on fossil nautiloids, he instilled in me a love of palaeontology and systematic order. He agreed to supervise my doctoral thesis, and despite my efforts he still finds the taxonomy of Carboniferous bryozoans rather perplexing. In truth I cannot claim to understand the complexity of nautiloid taxonomy! He has a wonderful way of encouraging independent research, and allowed me to follow my own rather varied research interests in palaeontology and in history of geology. Unfortunately, in the modern arena where research exercises have assumed too great an importance, many university academics are forced to carry out research in an area which appears to be of greater value to their department in gaining credit than the field to which their instincts take

them. I am happy to count both Charles and Gordon as friends, and appreciate all that they have done for me.

Many colleagues, friends and family have helped me in various ways, both directly and indirectly, in the preparation of this book and if I have omitted anyone from this list I sincerely apologise. For their assistance I thank Bill Ausich, Peter Bowler, David Branagan, Bill Brice, Stephen Brush, Duncan Burns, Norman E. Butcher, Albert Carozzi, Stephen Coonan, Gordon Craig, Brent Dalrymple, Bill Davis, Dennis Dean, Hal Dixon, Ellen Tan Drake, Silvia Figueirôa, John Fuller, Greg Good, Gordon Herries Davies, Kathleen Histon, Charles Holland, Mary Spencer Jones, Ted Nield, Marcus Key, Jr, Martina Kölbl-Ebert, Gary Lane, Cherry Lewis (who encouraged me to write this book), Mark McCartney, Donald McIntyre, Ursula Marvin, Eugenij Milanovsky, Nigel Monaghan, David Murnaghan, Sally Newcomb, Chris Nicholas, John Nudds, David Oldroyd, Matthew Parkes, Michael Roberts, Ed Rogers, Martin Rudwick, Ian Sanders, the late Bill Sarjeant, Len Scott, George Sevastopulo, Crosbie Smith, Adrian Somerfield, Margery and Larry Stapleton, Ken Taylor, the late John Thackray, Hugh Torrens, Ezio Vaccari, Gerry Wasserburg, Denis Weaire, the late David Webb, Leonard Wilson, Peter Wyllie, John Wyse Jackson, Michael Wyse Jackson, Peter Wyse Jackson and Ellis Yochelson.

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