Introduction to *The ChronoZoom Time Atlas of Earth History and Big History*

"History" is commonly thought of as the written record of human activities, but in the last few decades, *scientific* historians have discovered an enormous amount of information about the past, before the appearance of writing. Geologists and paleontologists have been very successful in documenting Earth and life history in great detail, and much information is now available also from archaeology, molecular biology, astronomy, and cosmology. "Big History" is the currently active effort to bring together in a unified way all of the information about the past, both humanistic and scientific.

Founded by David Christian[1] and Fred Spier,[2] Big History aims to break out of the specialization characteristic of most historical writing and see the past as a unified field of study. It is now taught at a number of high schools, colleges and universities, and has a growing literature, an International Big History Association, and a *Journal of Big History*. The Big History Project of David Christian and Bill Gates is developing Big History as the centerpiece for 9th-grade education, to take advantage of the intense excitement this approach to history brings to students, which all who have taught it have observed. Among the present authors, Walter and David definitely observed this excitement while teaching Big History at Berkeley.

One of the problems for anyone teaching Earth history or Big History is how to get the students to comprehend the time scales. Students soon come to understand that Earth history, back to about 5,000 million years ago, is about a million times longer than written human history, going back to about 5,000 years ago, so that the basic time unit for geologists is "million-years." But it is much more difficult for them to wrap their minds around the *concept* of a million years, or 5,000 million years. In fact, it is probably impossible for *anyone* to do thisl, given our lifetimes of not much more than a century. Diagrams do not help much, for on a linear diagram, human history is invisibly brief, while a logarithmic scale, although expanding human history, distorts the time scale so much as to make it completely misleading.

After a discussion of this problem in the Berkeley Big History class in 2009, Roland, then one of the students, suggested portraying deep time using computer-zoom technology. His initial proof of concept, presented to the class, was so successful that he began working with Walter and David, leading the effort to develop what came to be called ChronoZoom. Microsoft got interested in the project, supporting the Berkeley design team and developing the code. A first version, ChronoZoom-1, was developed by Microsoft Live Labs, and a second version, ChronoZoom-2, by Microsoft Research, with Roland leading the design work. This third version, ChronoZoom-3, uses panels drawn by Walter, and was tested in a course in History and Evolution of Planet Earth (EPS 102) taught by Mark, with Alexis and Roland responsible for much of the design and coding.

ChronoZoom-1, prepared quickly for a public lecture,[3] simply included graphic information relevant to the lecture. The second version had a different goal — it was intended to be crowd sourced like Wikipedia, to be populated with information by anyone who wanted to participate, and is available on-line for interested users.[4] The current version, ChronoZoom-3, is designed to be a teaching and reference tool, so the graphical information has been selected to convey a clear picture of major features of Earth history and Big History.

The first two versions of ChronoZoom were designed for continuous zooming; this new one is based on about a dozen graphical Panels, each of which can be examined individually, but which can also be thought of as a zoomable sequence. Having the zoom segmented by the panels helps the user avoid getting lost in what seems a wilderness of time. The panels cover intervals of time that differ by about a factor of ten, but rather than rigid, order-of-magnitude separations, each panel begins at a significant date in history. Since many significant dates in Big History begin approximately with the number "5," this is taken as roughly the beginning date for the start of each panel. The main exception is the Cosmos panel, beginning at the Big Bang, 13.8 billion years ago.

The plan for the panels is shown on the right of the next page, as a graphical index. It is drawn on a logarithmic scale, for only in that way can all the panels be shown. However, all but one of the panels are presented on linear time scales, which is the whole point of ChronoZoom — to give an undistorted graphical representation of the past. The only exception to the linear panels is Panel 0, which portrays the Big Bang, and in fact, all of Big History. The Big Bang covers time back to 10^{-43} seconds after "the beginning," and to show that many orders of magnitude on linear panels would require a very large number of mostly-empty drawings; a log plot is the only reasonable solution. Conveniently, after the Cosmos panel, there are three panels that show Earth and life history, three more covering pre-literate human history, and then three more since the invention of writing. For the last three panels, covering literate human history, only some background information about human population and natural disasters is shown. Human history is too complicated and detailed to be portrayed here, so users may wish to print out the panels and draw in the history that interests them.

Finally, there is a coda of two more panels, not showing much of historical interest, but included in order to take the zoom all the way down to one day, again for personal use. From one day to the entire duration of the Universe is a zoom factor of 5 trillion. The last two text pages are devoted to a kind of summary, first discussing the origin of the dating that lies behind the historical synthesis presented in ChronoZoom, and then considering the nature of history, and how its character might be understood.

Each panel is accompanied by a page of text, discussing the historical features shown in the panel. The layout of this version of ChronoZoom was inspired by the historical atlases of Colin McEvedy,[5] and following his design, may be best viewed on a computer and external monitor, placed side by side. The full PDF of the ChronoZoom Time Atlas can also be printed out in book form.