

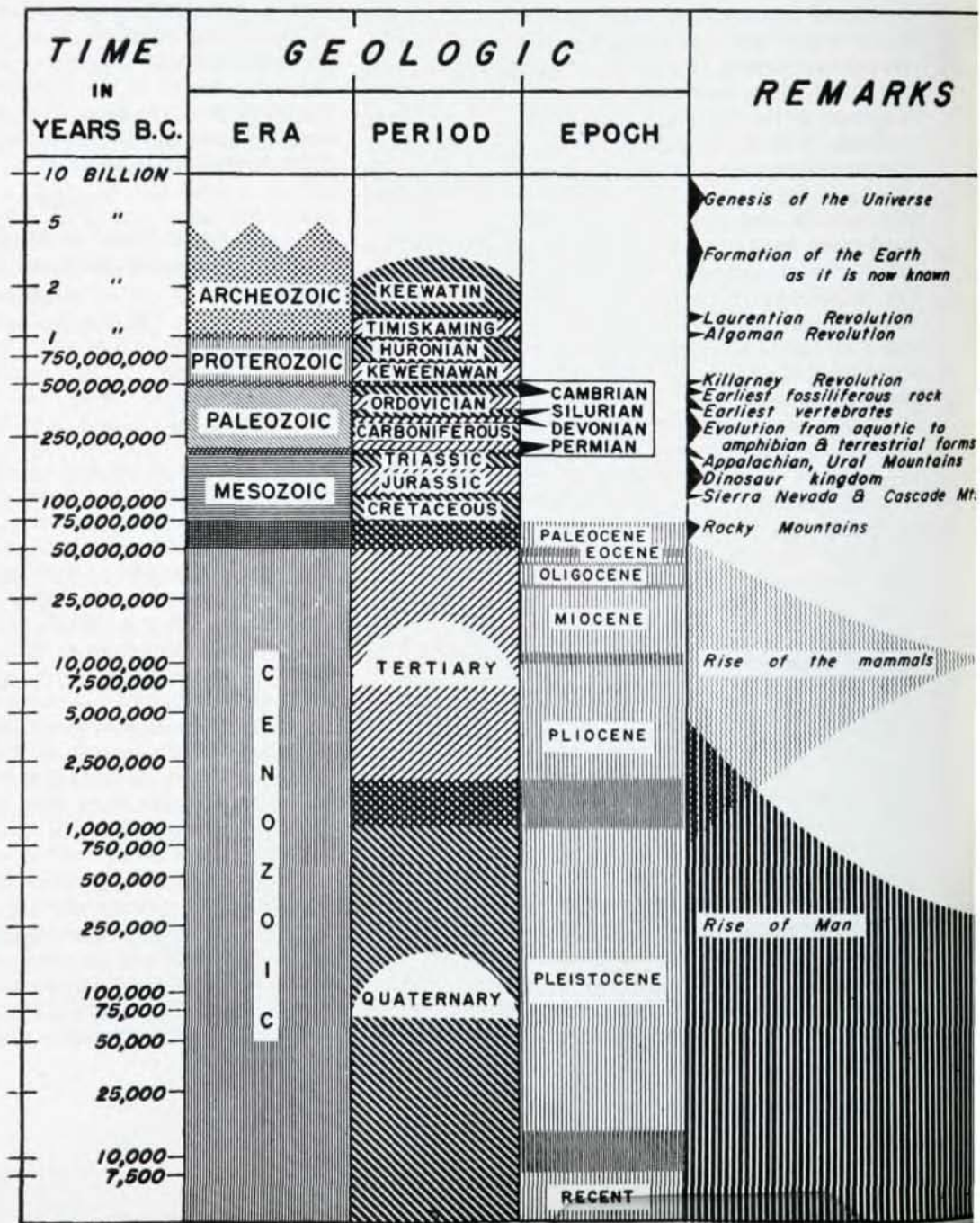
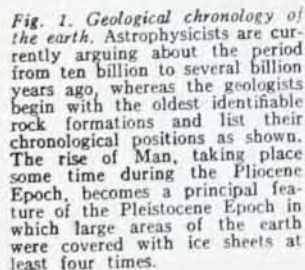
GREAT ICE AGES

By Carl A. Zapffe

Mankind, in one place or another, has had to contend with a lot of ice during the last million years without knowing where it came from. The author, a Baltimore metallurgist, has a suggestion.

WITH the exception of the Hiroshima bomb and Darwin's voyage on the *Beagle*, few developments of science have had as great an impact upon the human imagination as Agassiz's announcement in 1837 that currently habitable portions of the earth had been covered in geologically recent times by ice sheets thousands of feet in thickness and covering millions of square miles. At first hotly contested, the postulate finally gained universal acceptance because of such indisputable evidence as typically glacial till, drift, and boulders transported hundreds of miles from their bed-rock origins; deep abrasion markings on the surface of bed-rock recording the grinding flow; moraines and hills of glacial deposits along with typical lakes, rivers, and so forth.

Now at least seven glacial ages are known in the geologic history of the earth. Figure 1 shows this history schematically on a logarithmic scale, from the presumed time of the origin of the universe down toward the be-



ginning of those nations from which modern civilization stems. Glacial ages have been established back at least as far as the Huronian Period which followed the diastrophism known as the Algoman Revolution. This in itself is an interesting fact in that it establishes temperate and even frigid climates back a billion years.

Of principal importance is the fact that some of the most extensive glaciation in all earth history occurred in the Pleistocene Epoch, shown in Figure 1 as immediately preceding the Recent Epoch in which we now live. Four times within this stretch of a million years there were great ice sheets reaching completely across the continent of North America, and from northern Canada as far south as Kentucky. In Europe, corresponding sheets pushed out from the Scandinavian highlands across the Baltic into southern Russia, and across the North Sea into England and Belgium. The belt extended eastward along the mountain ranges of Eurasia

from the Caucasus in the west to the ranges of China and eastern Siberia. The snowline around the earth was depressed thousands of feet, in the tropics as well. Figure 2, Column 1, details this Pleistocene Epoch, the four glacial stages being the Nebraskan, Kansan, Illinoian, and Wisconsin, this last having at least four recognized substages as shown. The interglacial ages, representing recession of the ice sheets and restoration of a milder climate, are also shown.

Exactly within this period of phenomenal physiographic features, Mankind appeared. Pleistocene glaciation thereby attains special importance because of the interrelationships of glaciology and anthropology. Column 2 in Figure 2 summarizes the current anthropological picture, with the typical named finds related to the glacial chronology about as closely as present knowledge allows. Column 3 in this same figure summarizes the cultural developments of mankind as currently de-

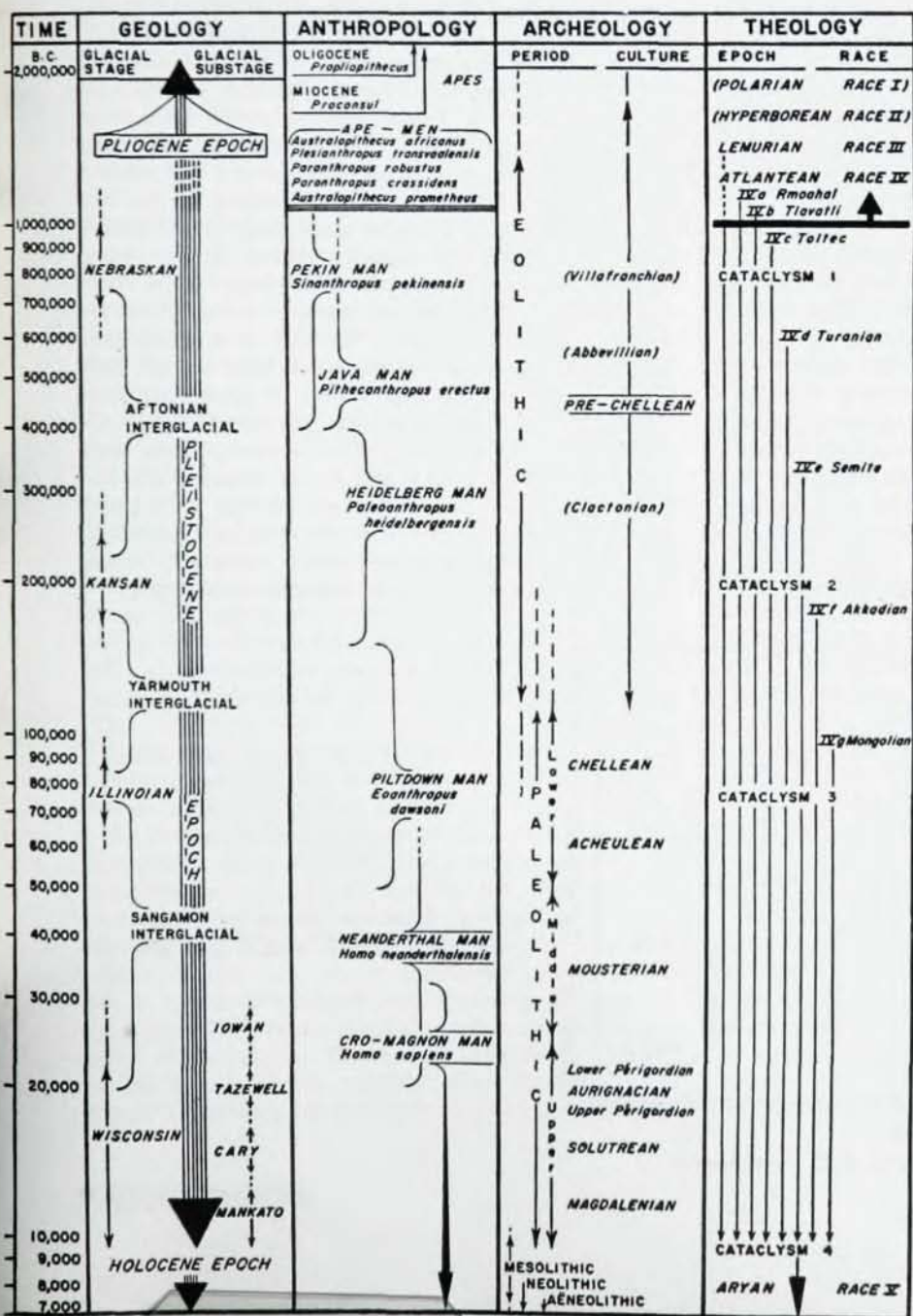


Fig. 2. Detail of the Pleistocene Epoch. The four major glacial stages are shown in column 1 along with the interglacial ages. Column 2 summarizes the anthropological story of Man from the current African discoveries of apemen down to the arrival of Homo sapiens. Column 3 summarizes the archeological story of the great cultural developments of Stone Age Man, with their chronologies placed about as closely as current evidence warrants. Column 4 lists the development of mankind according to esoteric theology, which is significant in its placement of four great Cataclysms along the Mid-Atlantic Ridge at times conforming closely to the best current estimates of glacial maxima, and agreeing in a relationship of Cataclysm 4 with the Mankato Maximum.

terminated by archeologists. The Chellean Culture approximately divides the elementary from the mature working of implements and artefacts in the archeological story, just as the Cambrian Period in the geological story introduces the marked development of life on this planet.

TODAY these vast and recurrent Pleistocene ice sheets remain unexplained. So-called Cosmic Hypotheses have postulated fluctuations in either the output or the intake of solar radiation, due variously to sunspots, interstellar disturbances, or passage of the Solar System through a dark nebula. These all suffer from the common criticism that glaciation has not been cyclic in time, that it has not been centered from the Poles and symmetric with them, and that the glaciation seems to have been catastrophic in onset rather than gradual. More seriously perhaps, a postulate of decreased solar heat presents the problem of decreased evaporation, whereas the level of the oceans dropped several hundred feet in supplying the water that formed the glaciers.

Similarly, Planetary Hypotheses, postulating orbital shifts of some sort, fail because the glaciation was mutual to both hemispheres, rather than exclusive. Also, there is no astronomical basis for crediting such a shift, since it would have imposed measurable changes upon the trajectories of the other planets. Geophysical Hypotheses, claiming alternating emergence and subsidence of continental topography, lose force in the face of the present unglaciated plateaus in Tibet and Pamir at elevations exceeding 15 000 feet, and particularly the fact that the mountain ranges of Alaska were relatively unglaciated during Pleistocene times whereas the Mississippi Valley was heavily covered. Atmospheric Hypotheses have variously based the observed climatological changes upon a varying H_2O/CO_2 ratio, volcanic dust, a zonal belt of debris in the nature of a planetesimal ring, and so forth. Others are too numerous to mention here; all remain unconvincing for one reason or another.

Although principal current discussions are along the

lines of solar radiation, the Volcanic Dust Hypothesis has long remained one of the most impressive approaches to the problem except for one outstanding weakness: Where are volcanic sites of Pleistocene Age sufficient to account for such fantastic excesses of glaciation?

Within the past few years oceanography and nuclear physics have provided the answers required for formulating what may be called a *Submarine Vulcanism Theory*. Briefly, Operation Midpac has shown the Pacific Ocean floor to be studded with immense volcanic cones and calderas, vastly larger than any on the continents and extending from the Gulf of Alaska, on the one hand, to such known areas of vulcanism as the Philippine Islands, Hawaii, Borneo, Java, New Zealand, and so forth. Petrographic studies show the truncated tops of these submerged volcanoes to be products of beach erosion and as recent as the Miocene or Pliocene Epochs shown in Figure 1. More specifically for the Pleistocene glaciation under discussion, the Woods Hole Oceanographic Institute has succeeded in defining the Mid-Atlantic Ridge as a range of submarine vulcanism 300 to 600 miles wide and extending almost 10 000 miles from Iceland to the Antarctic Circle except for a break at the Romanche Trench near the equator. This ridge separates the Atlantic Ocean into eastern and western basins, the peaks of the ridge averaging 10 000 feet above the ocean floor, some protruding as the islands of Azores, Ascension, Gough, Bouvet, and so forth. Bermuda is a 15 000-foot mountain rising farther above the ocean floor than Mount Whitney stands above sea level, and Pico Island at 27 000 feet is comparable to Mount Everest. Dredging operations have brought back beach sand; and it is the opinion of the Woods Hole staff that this sand layer was deposited during the Pleistocene Epoch. Finally, the oceanographers have shown that both North and South America are surrounded by a continental shelf sloping to approximately 300 feet and cut by tremendous submarine canyons whose origin was apparently terrestrial, during the Pleistocene Epoch, later becoming submerged.

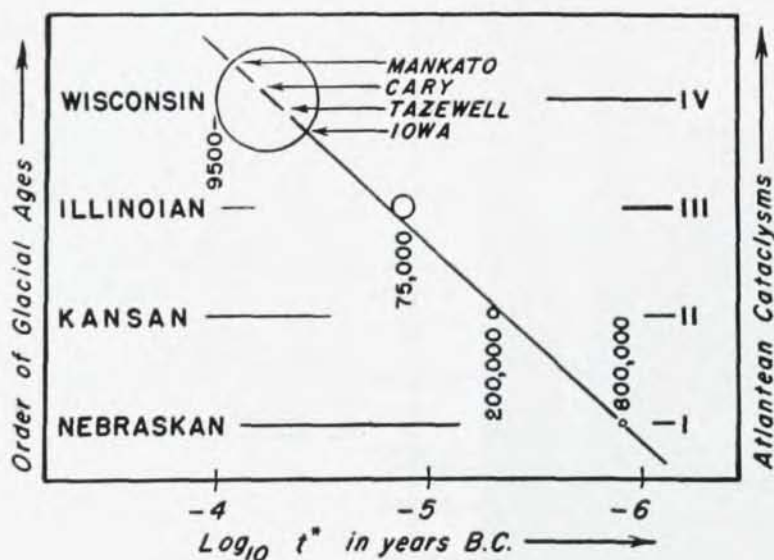


Fig. 3. Logarithmic plot of the dating from Column 4 in the preceding figure. The circles express a variation of ± 10 millennia.

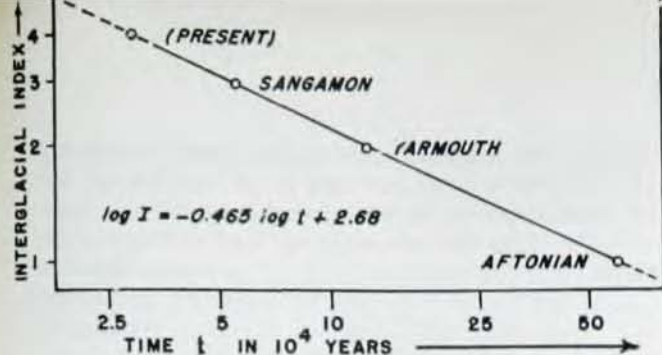


Fig. 4. Log-log plot of the interglacial ages vs. their index number. The plot is so remarkably linear that it is extrapolated to measure the present post-glacial time in terms of an interglacial age between the Wisconsin and some future cataclysm centering near 10 000 A. D.

FROM the field of nuclear physics, radiocarbon dating has now provided a precise placement of the Mankato Maximum—the last of the ice advances—at 9500 B.C. $\pm$ 500 years. This figure immediately brings to mind the classically famous *Timaues* from the Works of Plato, in which Solon is told by the priests of Egypt that the remains of a great continent in the Atlantic Ocean sank cataclysmically about 9500 B.C. More than five thousand books have since been written on the controversial subject of the Lost Continent of Atlantis, there being today an established Atlantology. Intimately interwoven with religion and with the legends of floods and deluges which characterize virtually every race on earth, the Atlantic story will be found to disclose information which is not only surprisingly conformable among widely placed sources, but is sufficiently precise to allow technical study. Column 4 in Figure 2 briefly summarizes the position of esoteric theology as taken from the works of Steiner on Anthroposophy; Blavatsky, Besant, and Leadbeater on Theosophy; Heindl on Rosicrucianism; also the extensive Edgar Cayce records at Virginia Beach. Four Cataclysms are named, just as four Glacial Ages are known within the same period. Cataclysm 4, of which Solon spoke, has for untold centuries been placed close to 9500 B.C., and specifically at 9564 B.C. Cataclysm 3, out of present reach of radiocarbon dating, is sometimes generalized at 80 000 B.C., but given specifically at 75 025 B.C. This conforms with current estimates of the Illinoian glaciation; and the same is true for Cataclysm 2 placed at 200 000 B.C., and Cataclysm 1 placed at 800 000 B.C., conforming respectively to the Kansan and Nebraskan glaciations.

Using these specific figures from the field of esoteric theology, one finds that they lie very close to a straight line on a logarithmic plot, as shown in Figure 3.

An even more remarkable exactitude results when the Interglacial spans are plotted on a log-log scale against the index or order. Figure 4 shows the relationship to be so remarkably regular that it can scarcely lack significance. Its extrapolation into the present time indicates that this may be not only a postglacial period, but a fourth Interglacial Age occurring between the recession of Wisconsin glaciation and a recurrence centered approximately 10 000 A.D. The four substages of the Wisconsin are centered about 20 000 B.C. in Figure 3, spanning ten millennia to either side with the

posterior boundary known. The calculated Interglacial span of approximately 30 000 years then reaches to 10 000 A.D.; on the other hand, the margin 10⁴ years used in these calculations means that we are at present past the middle of the Interglacial Age, that the climate will continue to become warmer as the Age proceeds, but that a great new Glacial Stage might develop any time from now on.

IN briefly summarizing this Submarine Vulcanism Theory, four successive and major diastrophisms of orogenic or mountain-making sort presumably occurred during the Pleistocene Epoch along the region known as the Mid-Atlantic Ridge. Molten rock poured from volcanoes and earth fissures, possibly representing a flow covering a million square miles and representing a total extrusion measured in the hundreds of thousands of cubic miles. The calculations, which cannot be given here, lead to primary explosions under pressures exceeding 10⁴ psi, filling the atmosphere to stratospheric heights with a blanketing dust greatly decreasing subsequent absorption of solar radiation; volatilization of the order of 10⁶ cubic miles of water in the form of superheated steam, this accounting for the legends of great deluge disasters; this followed by a progressively decreasing evaporation of sea water, the temperature of the Atlantic Ocean having been raised an average of about 4° C.

With the center of emanation along the Mid-Atlantic Ridge, these excessive quantities of moisture would then logically precipitate as torrential rainfall over temperate land areas, and as snow immediately upon encountering the freezing isotherms. The theory thus accounts for the most puzzling feature of Pleistocene glaciation, which has been its localization along the coasts of North America and Europe bordering upon the northern reaches of the Atlantic Ocean, with precipitation decreasing so markedly westward and northward that Alaska remained almost untouched.

With the polar asymmetry explained in this manner, the world-wide influence of the phenomenon next becomes explained by the classical Volcanic Dust Hypothesis, since this has always been granted an ample reason for glaciation once sufficient volcanic activity is identified. The exception to this statement stands in a previously puzzling observation that certain great periods of volcanic activity have not been attended by glaciation. The Submarine Vulcanism Theory, requiring a combination of vulcanism and marine interference, makes allowance for such exceptions. A thermodynamic cycle is involved in which an evaporation source is given an increased temperature, whereas the precipitation areas may actually lose temperature through atmospheric blanketing. As the potential of this cycle is reduced, the ice sheet reaches its maximum extension, and thereafter a long period of recession begins in which the Earth is finally left with an energy balance, so far as climate is concerned, made up from the difference between the gain from subterranean effusion and the loss from solar blanketing.