The youngest big impact on Earth deduced from geological and historical evidence

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ABSTRACT

The comparison of events that followed the great impact at the Cretaceous/Tertiary boundary with those contained within the Flood myths suggests an analogous cosmic cause. This paper proposes that there is geological evidence to support this thesis which is also indicated by a careful analysis of the natural phenomena described in Flood traditions. The time, the sites, the cause, the detailed course of the events and the consequences of this catastrophe can hope to be reconstructed.

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INTRODUCTION

If a geologist – with recent knowledge about impacts – studies the great human traditions concerning the biblical Flood, starting with the Vedes, the Gilgamesh epic and the Edda and advancing to the myths of the American Indians and the reports of the aborigines of Australia, then he/she will consider worldwide records of the sequence of major earthquakes, an enormous pulsation, wildfire, flooding with its monstrous sea waves, torrential rain, permanent night for many days, permanent winter and mass extinction of beasts, to be distinct hints of the effects of a great impact with worldwide consequences during the lifetime of *Homo sapiens*. The folk memory of the event has been sustained over long periods, at first by oral tradition and only in very recent times by written records.

There remains a central problem: in what way can this fundamental incident of human history be corroborated by scientific methods; i.e. how can the scientist distinguish between the reality and the illusion? At first it seems hopeless to try to resolve this old problem, particularly considering the existing 80,000 or so publications in 72 languages that have already considered this matter. Most of these are admittedly rather speculative; in none of them can one find a scientifically well-established date for the Flood nor a detailed account of the course of this event or the indications of still-preserved proofs of such an extraordinary stroke of fate.

We opine that the only way to resolve this is to try to combine and compare critically three strands of knowledge on this topic:

1 Modern knowledge about the impact process furnished by Alvarez *et al.* (1980), analysing the impact at the Cretaceous/Tertiary boundary, and by the thousands of publications stimulated thereby in the ensuing research boom during the 1980s.

2 The collection of all relevant geological facts scattered through the recent geological literature, concerning tektites and other fundamental global events dated approximately just under ten thousand years ago in the older Holocene, and still lacking any overall synthesis.

3 The analysis of reports about the physical processes included in many hundreds of myths and traditions about the Flood, which have been preserved orally in the folk memories of most cultures around the world. Most of these myths have been collected in the past two centuries, but the analysis of this treasure of traditions by ethnologists took place at the beginning of our century, and from points of view very different from those of a geologist, namely, the perspective of the humanities. Earth scientists have traditionally rejected the inclusion of arguments outside the natural sciences in the analysis of this problem – as if oral history possessed no validity.

It was inevitably necessary – considering the delicacy of this subject – to establish a series of controls by different methods in all three of the procedures mentioned above. Only broad interdisciplinary research could succeed here, encompassing not only the different natural sciences, but also including the humanities.

THE FLOOD IMPACT

The purpose of this paper is to present new insights into the Flood impact (the darkest chapter of human history) at least for the English-speaking reader, because in the German language there already exists some comprehensive descriptions (E. & A. Tollmann, 1992;

A. & E. Tollmann, 1993). In the following we present a complete (but necessarily imperfect) synthesis of these arguments to explain the sequence of events.

The arrival of the bolide and its character

The first information about the approach of the disaster is given by a Peruvian myth (Howorth, 1887, p. 453): "they pointed to six stars close together, and declared that they were a sign that the world would shortly be destroyed by a deluge." Many other myths confirm that this impactor was a comet ('Schweifstern'), e.g. the Persian Jescht-Mithra and Bun-Dehesch myths (Rhode, 1819, p. 19) or the holy book of Zend-Avesta (Lüken, 1956, p. 186), which described the long tail, extending far along the Zodiac.

The fragmentation of this Flood-bringing comet into seven major pieces is recorded in several traditions: according to a Jewish legend, Henoch described these seven invading "stars" as great burning mountains (Roloff, 1984, p. 99). The myths of India describe the approach of many terrible suns (Hohenberger, 1930, p. 21).

We know from recent observations that the fragmentation of comets, consisting mainly of water-ice, is a common phenomenon. During the last hundred years such events have been observed around 20 times. Recently, the big comet Shoemaker Levy 9 broke up during its passage through the gravity field of Jupiter into a series of 21 fragments, which are now circling around that planet. It appears that the Flood comet, too, had already broken into pieces under the influence of Jupiter and not only due to its near passage in the perihelion, because its several impacts on the Earth followed with differences of many hours or days. This can be deduced from the worldwide location of the impact sites in the context of a rotating Earth, but also from the Gilgamesh epic, which records an initial rain of mud and grains on the evening before the (Indian Ocean-) impact the next morning (Schott, 1984, p. 96).

Today we possess some geological proof that several (probably seven), big fragments (and also some smaller ones) hit the Earth (Fig. 1): e.g. tektites with an age of nearly ten thousand years are known from Victoria in southern Australia (Baker, 1959, p. 116; Johnson, 1965, p. 5f.; Gill, 1970, pp. 997, 1001) caused by an impact SE of Tasmania; but also tektites in Vietnam (Izokh, 1987, p. 380ff.; 1989, p. 96) derived from the impact in the southern part of the China Sea, suggesting that the impact direction of the comet was SE to NW.

Furthermore, some sites are characterized in the myths by the mention of caustic blood-coloured rainfall. We could explain this reddish-brown precipitation as the fallout of the impact-generated nitric acid of such colour, saturated with nitric oxide. This type of 'bloody rainfall' is typical for the areola of an impact site. In different myths, such sites were recorded from the northern Atlantic, the western Indian Ocean and the Eastern Pacific off the coast of Central America.

The impacts

All the major fragments appear to have impacted into the ocean. Only minor splinters hit the continents. One which is well-established is the impact of such a splinter of this event in Köfels in the Ötz valley in Tyrol (Austria) – see below. No craters in the ocean are known, perhaps because nobody has looked in the appropriate areas.

This fall of large fragments and smaller accompanying splinters was linked with the fall of 'shooting stars'. Many myths around the world record this phenomenon linked with the Flood catastrophe: "The stars of the heaven fell down upon the earth, as a fig-tree drops his fruits" said St. John in his revelation (*Holy Bible*, ch. 6, 13) – (Fig. 10). In the *Lieder-Edda* it says in verse 44 of the Völuspá: "From the heaven tumbled the bright stars" (Genzmer, 1920, p. 42). The Washo Indians of the Hoka in California relate in their oral tradition: "The stars melted, so that they rained like molten metal."

There even exist eye-witness accounts of the main impacts by the major fragments, handed down by oral tradition. We give three examples:

1 The *Edda* records in the Gylfaginning that the fire-giant Surtur came down from heaven at the front of a swarm of fiery sons of Muspels like a wonderful sharp sword surrounded by fire and flashing brighter than the sun (Stentzel, 1894, pp. 151, 162). From this description one can gather that this impact (in the northern Atlantic) was a straight plunge, accompanied by a swarm of smaller fiery splinters.

2 The impact in the Indian Ocean is suggested by the old Indian *Ksemendra* (chap. 1, verse 34–35) and also the *Puranas* (Frazer, 1919, p. 189; Hohenberger, 1930, p. 11): the impact in the ocean gave rise to a "ring of fire with the appearance of a multitude of tongues of the god of death" and the

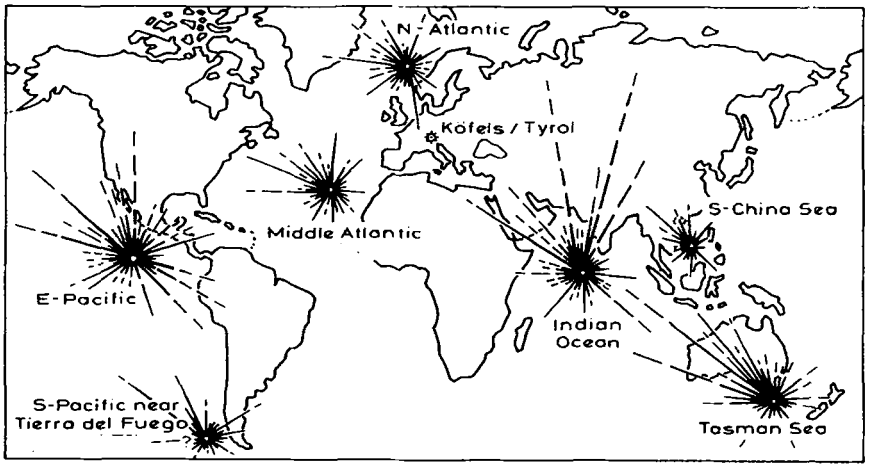

Fig. 1. *The impact location of the seven main fragments of the Flood comet and the impact on land at Köfels in Austria (according to Kristan-Tollmann and Tollmann, 1992, p. 19, fig. 3).*

submarine fire exploded (Fig. 2). Though this picture is declared as a prophesy, it may reflect as a whole the remembrance of the Flood event.

3 The Chinese motif of the dragon may provide an impressionistic rendering of the impact in the southern China Sea. In use since the Han dynasty (206 BC–AD 220) as official symbol for the insignia of the emperor, the dragon motif can be interpreted to represent a marvellous artistic synopsis of the impact event: the dragon itself symbolizes the tail of the comet, deformed by the currents in the atmosphere, and the ball in the centre with tongues of fire is the head of the comet, surrounded by little splinters with fire (on very complete pictures nine 'sons of the dragon'), all depicted in a framework of clouds. At the base one can see a cone of waves, a result of the gigantic sea turbulence after the impact? And above the sea a ring of water, which has gushed up into the form of a tulip, is closely similar to the results of impact experiments performed by Schultz and Gault (1982). In Chinese drawings and sculptures the Flood impact in the China Sea may be recorded in detail (Fig. 3).

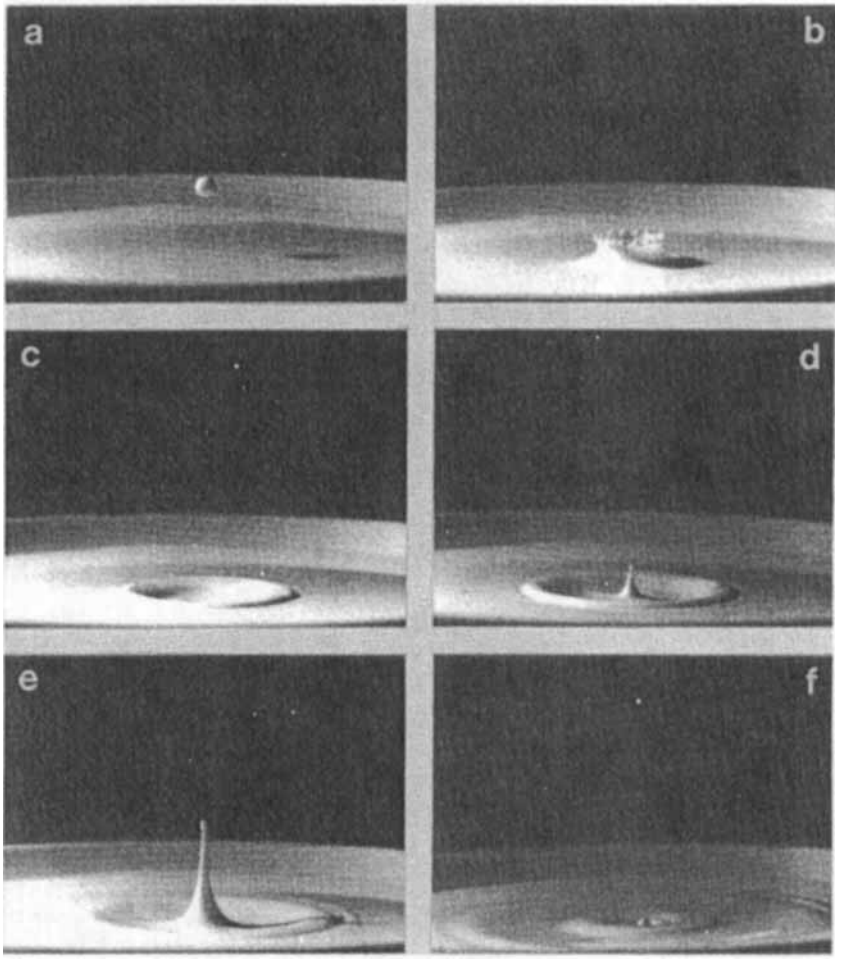

Fig. 2. *Time-lapse photographs of the impact of a body into water (Melosh, 1989, p. 142, fig. 8. 19). The wreath of water on fig. b corresponds exactly with the description of the impact in the Indian Ocean, given in the Indian Ksemendra myth (I, verse 34–35).*

The age of the impact

Although some concrete ideas about the timing of the impact concerning the hour and the month have existed for a long time, hitherto it has been impossible to find out the year of this event by historical or other conventional methods.

Let us first of all consider the evidence for the day and hour of this blow to the planet Earth. We know from the Gilgamesh epic that the impact in the Indian Ocean occurred "hardly that the dawn had appeared". Furthermore, according to many myths of the northern hemisphere, this event happened just at the beginning of the autumn. This means that it was at about 06.00 h in the morning in the Orient, equivalent to around 03.00 h Central European time.

In the folk memory of the Chippewaya Indians in Canada, the great snowfall around the Flood began in the month of September (Andree, 1891, p. 82). The priest Berosus in Babylonia recorded that the great Flood happened in the month "Daisios". Stentzel (1894, p. 137 f.) fixed the start of Daisios at the equinoctium of the autumn and stated that this date (23 September) would also be the beginning of the Flood.

Of interest is the close agreement in timing between the above and the traditions of the southern hemisphere. The Yámana people in Tierra del Fuego in South America date the start of the disaster exactly at the beginning of spring when the first "Laxuwa", a migrant bird, came back. This corresponds to the start of the northern autumn.

To solve the thorny question about the year of this event we nowadays have about half a dozen modern geological methods. The most important evidence is provided by the age of the tektites which are found strewn along the continuation of the flight path to the NW beyond the impact sites. The tektites in South Australia around Port Campbell (Campellits) (Fig. 4) have since 1938 been dated by stratigraphical methods as Lower Holocene, i.e. around 10,000 yr old (Fenner, 1959; Baker, 1965; Johnson, 1965). In response to critical voices, Gill (1970, p. 1001) revised the position of these tektites by extremely careful excavations and confirmed the age of the non-reworked tektites by the ^{14}C dating of the accompanying wood as around 10,000 yr.

Of particular interest is the age of an excavated tree-trunk *in situ* in

Fig. 3. *The dragon symbol from a Chinese woodcut. It symbolizes in a synoptic manner all details of the comet impact in the South China Sea (for details see text) (original: A. & E. Tollmann).*

Melbourne, which contained such a tektite that has lodged since its impact in the wood. Thirty years ago Suess dated a sample from the trunk (No. W-95) by the radiocarbon method at 8780 ± 200 yr. After modern correction in the light of the 8% higher ^{14}C values now accepted, we arrive at an age of 9520 ± 200 yr BP (cf. A. and E. Tollmann, 1989, p. 96).

Similarly Saurin (1935, p. 246; cf. Barnes, 1964, p. 35) and Izokh (1987, p. 380 ff.; 1989, p. 96) gave a stratigraphic age of about 10,000 yr to the non-reworked tektites from the oldest Holocene terraces in Vietnam. The fact that a large and much older tektite field of Australites aged 700,000–720,000 yr superimposes these two smaller and younger strewn-fields has caused considerable confusion (Glass, 1978, p. 1456).

Furthermore Prasad and Rao (1990, p. 340) detected such a young tektite, Campbellite, on the bottom of the Indian Ocean, which was not deeply buried, but very near the surface of the sediment.

The continental impact at Köfels in Tyrol (Fig. 5) could also be dated by the radiocarbon method (Heuberger, 1975, p. 233). Calibration in the light of present knowledge results in an age since the impact of almost 9440 ± 150 yr (A. & E. Tollmann, 1993, p. 140, 252).

An analogous hint at the date of this great event is also given by investigation of the Greenland ice-cap, performed by deep drilling (Hammer *et al.*, 1980). The annual stratification in the Camp Century bore hole in NW Greenland demonstrated that the maximum fallout of acids of the whole 9890 year ice-core, happened at 9630 ± 170 yr BP, surpassing all other peaks of acid from volcanic activity (Fig. 6). The marine impacts may also have produced large quantities of acids, not only hydrochloric and sulphuric acids deriving from the ocean water, but particularly also nitric acid arising from the interaction of nitrogen, oxygen and water vapour in the atmosphere.

The Flood impact may also be dated exactly by dendrochronological methods. We know from measurements at the time of the fall in 1908 of a 100 m splinter of the comet Enke, in the area of the Stony Tunguska in Siberia, that as a result of this minor event one third of the ozone layer was destroyed; by this means the incoming radiation was enhanced in a pronounced manner, increasing remarkably the production of ^{14}C in the atmosphere. Thus, we might expect a rapid increase of atmospheric ^{14}C due to the Flood impact, which would be retained in the wood of the trees alive at that time. In 1990 the German botanists Kromer and Becker announced that they had not only extended dendrochronological knowledge by the investigation of German subfossil oaks back to the year 9920 BP, but had also measured the amount of radiocarbon in the rings of these trees at each period. According to the dots of their ^{14}C-curve we find an exceptional peak about the year 9545 BP (Fig. 7). We are convinced that this peak indicates the Flood event, and we expect, furthermore, that a detailed examination of the tree-rings from that time might bring to light the exact year of the impact.

Finally we should not forget that the recent ^{14}C-measurements of the well-preserved tissue from the youngest hitherto discovered Siberian mammoth from the Yuribey river indicated an age of 9600 ± 300 yr BP (Dubrovo, 1990, p. 4). Therefore, the long-discounted opinion of Cuvier that the mammoth was extinguished as a species by a worldwide catastrophe followed by a long and strong winter – according to the *Edda* (R. Derolez 1976, p. 186) it lasted three years after the Flood – may even be rehabilitated. Such long winters would have been a sentence of death for the mammoths.

A more exhaustive insight into the determination of the age of the Flood event is given by A. & E. Tollmann (1993, pp. 248–264).

The course of events after the Flood impact

Until recently the succession of events after an impact on our planet has been obscure. By the reconstruction of the occurrences of the impact at the boundary of the Cretaceous and Tertiary periods, we now possess a detailed picture of the course of events in such a cosmic catastrophe. The multitude of direct experiences of the peoples of the Flood impact period can now be matched with this prehistoric event. The comprehensive synthesis of all important original traditions provides much more insight than any individual eye-witness could gather in its restricted field.

In the following we give only a brief review of what we consider to be the course of events, and for the rest have to refer to our specialized book of 1993 for more detailed descriptions and relevant proofs.

The consequence of the impact explosion appears to have included a chain of up to a dozen individual catastrophes, occurring hours, days or weeks afterwards. Comets, with their extremely high velocity of up to 73 km s^{-1}, release much more energy than asteroids. On impact, an enormous amount of energy is released, and is dissipated in the form of earthquakes, geological deformation, a vapour plume, a heat pulse, the ejection of solid material, tsunami waves, etc. For the impact at the end of the Cretaceous period, the release of energy was originally calculated as the equivalent of 5 thousand million Hiroshima atomic bombs (Turco 1983, p. 1284). This estimate must be raised today, since it has been recognized that the crater of this impact in Yucatan has a diameter of 300 km instead of 180 km as originally thought.

The first consequence of the Flood impacts was therefore likely to have included the spread of a heat pulse of great intensity. Those of the End-Cretaceous impact may have had a velocity of 1200 km h^{-1} and a temperature of 600°C. Many traditions tell us that after the flood impacts the world looked like a chaotic expanse of ruins (Fig. 8).

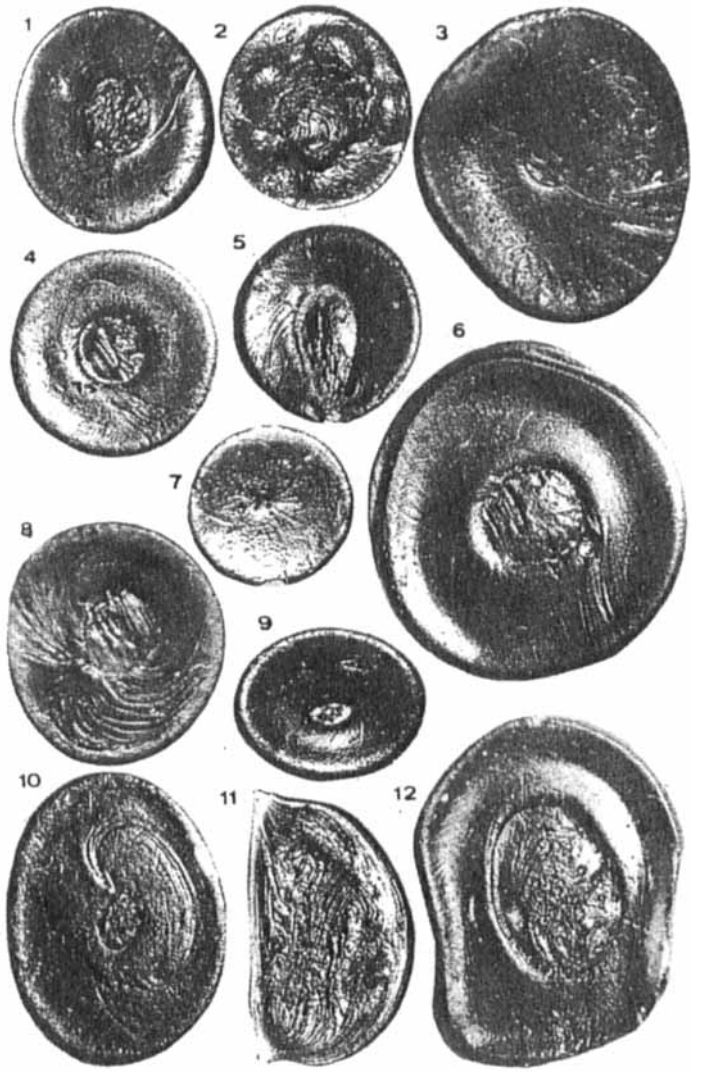

Fig. 4. *The tektites from Port Campbell in Victoria, southern Australia (after Baker, 1963 pl. 4).*

Stories also include descriptions of worldwide earthquakes recorded in all of the continents. The crust moved, according to these traditions, like the running high waves of the tempestuous sea, hurled people on their faces, uprooted trees, crushed rocks, broke down mountain crests and raised them elsewhere, changed the landscape and submerged many islands in the Atlantic and in the Indian Ocean (Jonsson, 1900, p. 598; Riem, 1925, p. 32; Boehmer, 1932, p. 118; Frazer, 1919, p. 227; Müller, 1930, p. 79 etc.) (Fig. 10).

Wildfire is also recorded blowing the great rivers out of their beds, as the oral histories of the Indians of California and the traditions in the Near East around the Euphrates record. The aborigines in southern Australia gave an account of the horrible heat coming down from a red hot sky. The heat was so extreme that people could not suffer it, and the men killed their children and wives and finally themselves (Walk, 1931, p. 76). Today, we can understand this terrible "Fire, which filled whole the space between sky and earth": Zahnle *et al.* (1990, p. 282 ff.) and Melosh *et al.* (1990, p. 251 ff.) recognized that the vapourized rocks of an impact, jetted as a plume in the sky, fall back to earth in the form of dense red clouds of melted small particles at temperatures of many hundreds of degrees.

The next phenomenon was the flood wave (Fig. 9). We know today from experiments that this wave can rise after an impact as high as the depth of the ocean at the affected site (Napier and Clube, 1979, p. 458). The wave diminishes only after travelling a great distance. Depending on the size of impacting fragments the continents could have been flooded far into their interiors. According to oral history the Alps, the Taurus, Zagros, the Himalayas and the eastern prolongation were not overwhelmed, suggesting that central and northern Asia were spared the flood. On the other hand, according to some stories the flood wave surmounted the western Cordillera of North America and penetrated deep

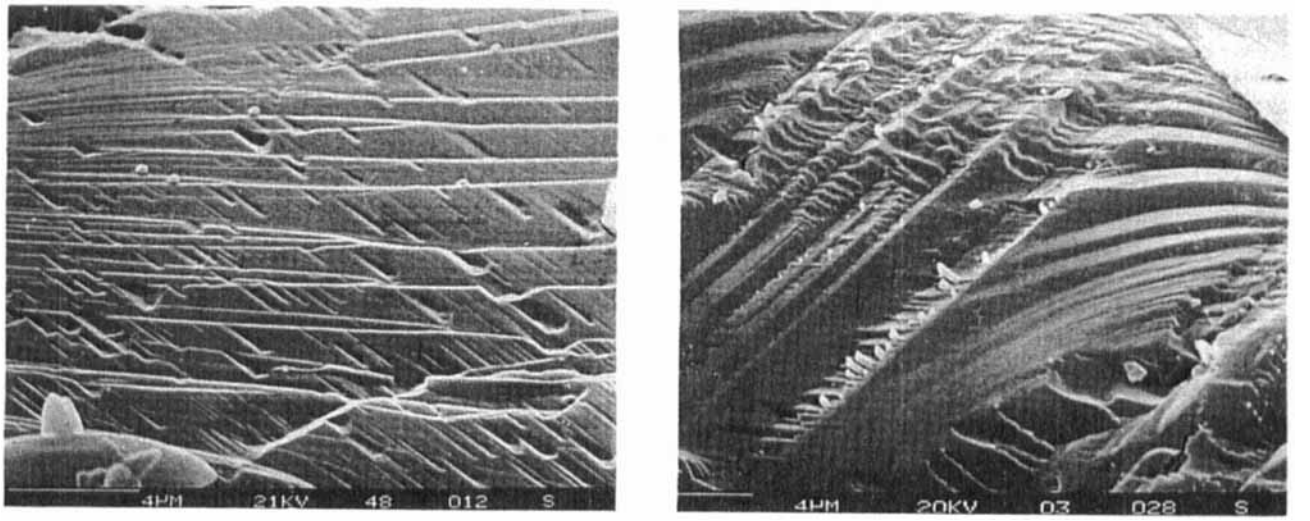

Fig. 5. *Shocked quartz in the gneiss from Köfels in the Ötz valley in Tyrol, Austria (Surenian, original and 1988, pl. 2/5).*

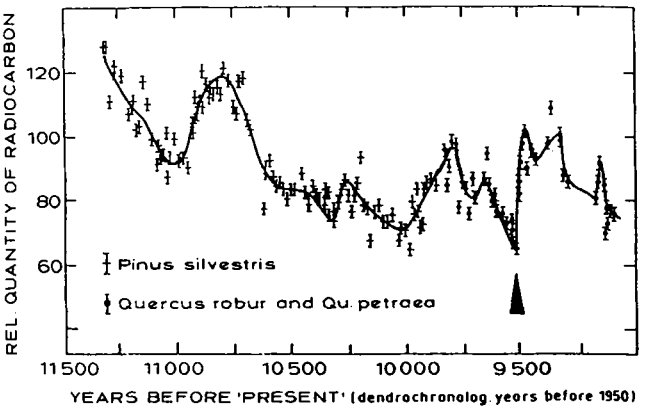

Fig. 6. (above) *The peak of radiocarbon just before 9500 BP in the graph, based on the measurements of Kromer and Becker (1990, diagr.).*

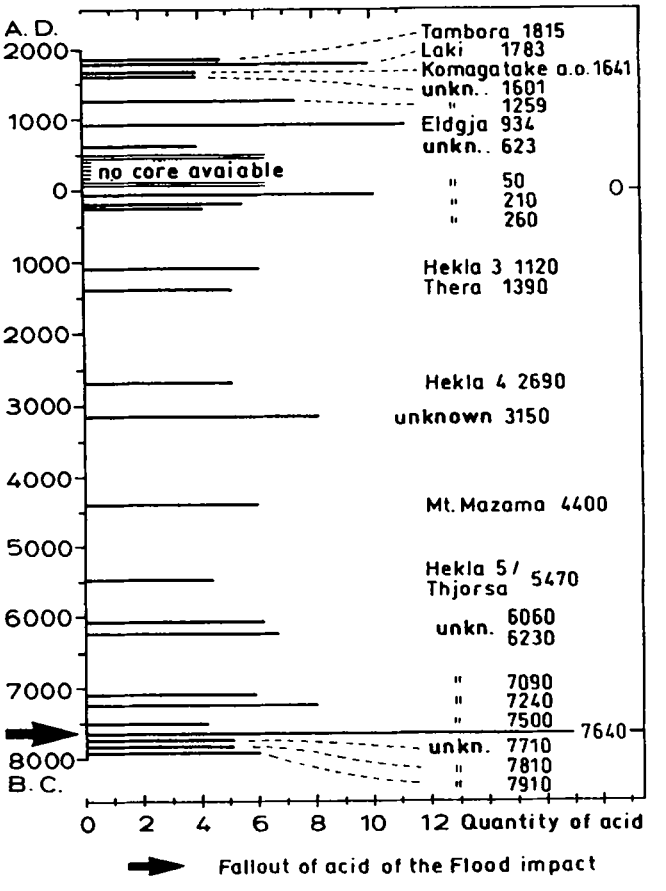

Fig. 7. (right) *The most intense fallout of acid in postglacial time, documented in the Greenland ice core of Camp Century, appears according to the graph of Hammer et al. (1980, p. 233, fig. 3) at 7640 ± 170 yr BC (= 9630 ± 170 yr BP). This event can be explained easily by the Flood impact.*

into the continent (Riem, 1925, pp. 99, 137; Donnelli, 1895, p. 142). The Andes, however, protected their hinterland. In many places the flood is said to have invaded the continents at boiling heat (Böklen, 1903, p. 40; Frazer, 1919, p. 227; Müller, 1930, p. 81, 85).

But even those parts of the continents which were spared the flood were affected by torrential rainfall, in many places also boiling. A boiling rainfall was recorded by several peoples, who also referred to raindrops as large as a head or as a "wigwam" (Lüken, 1856, p. 185; de Rougemont, 1856, p. 137; Andree, 1891, p. 80). The cause of this phenomenon has been suggested by the aerodynamicist Croft (1982, p. 150): the compact masses of water shooting into the sky came back boiling due to friction with the atmosphere.

Often the rainfall brought with it other substances like mud, soot and of course the acids produced by the impact. All these contents are described in many myths around the world. The fallout of nitric acid has been referred to as 'bloody rain' (Ziegler *et al.*, 1921, p. 40) after its reddish-brown colour (see above).

The ejection of colossal masses of dust by the impact explosions into the high atmosphere, combined with the large amount of soot from the wildfires, caused an increase in the reflection of the incoming light and heat from solar radiation. The 'night' which swiftly set in lasted for a whole week. Countless myths report with horror that the evil wolf (*Edda*) or a pernicious demon devoured the sun, the moon and the stars (Fig. 10). This impact 'night' came so quickly that in North America the Flood is said to have invaded the interior of the continent during the darkness (Riem, 1925, p. 99).

During this semi-permanent night the temperature sank very quickly. Therefore, according to the myths in elevated regions (such as Iran) and in the high geographic latitudes (*Edda*, traditions of the Yámana in Tierra del Fuego) the rainfall was soon transformed into snowfall. The impact winter continued in the regions mentioned for the next three years (*Edda*; Derolez, 1976, p. 286) and for an even longer period there was only a two month 'summer' (Iran; Rhode,

Fig. 8. *The end of the world by "Ecatococ", the god of the wind in the mythology of the Azteks, symbolizes the consequences of the Flood impact pulse (Seler, 1923, p. 51, fig. 28).*

1819, p. 21; Riem, 1925, p. 18). In the high latitudes of North America a layer of ice covered the land (Riem, 1925, p. 84).

The extinction of some elements of the fauna understandably would not arouse much interest among the people in this hard time. We have already mentioned that the mammoths may have died out as a result of the Flood impact. It is not yet definitely clear whether the other megafauna, the big mammals of the Pleistocene, which also become extinct at the Pleistocene/Holocene boundary, were also extirpated by this event: their extinction is dated generally at 11,000 to 10,000 yr BP, but according to Stafford (1990, p. 118) the determination of the ^{14}C-age for this period is affected by an error of 1000–1500 yr.

Finally there exists a short, but very informative report of the post-impact scenario, and hence of the re-creation of the world after the disaster. It is known under the title of "Genesis" and it is the first chapter of the Old Testament in the *Bible* (Fig. 11). Genesis explains the evolution of the world in several stages, but if one interprets this report as a description of the Creation the details are unlikely in many respects: the light did not come four days (periods) before the sun, the birds did not come before the reptiles, etc. However, if one sees in this picture the scenario after the Flood impact, then all is correct: Moses reported in Genesis the exact process of re-creation of the earth after the Flood.

Without entering into all of the later consequences of the impact (cf. A. & E. Tollmann, 1993, p. 233 ff.), it should be mentioned here that one consequence of the production of a considerable mass of greenhouse gases was a remarkably long warm period following this impact. The pollen diagrams of Austria (Draxler, 1980) show that the change to a warm climate started just after the impact, when atmospheric CO_2 also reached its maximum. This period lasted until 5300 yr BP with an increase in temperature of up to 4.5°C.

Many broadly based investigations in the natural and human sciences are now necessary in order to elucidate in detail the course of this impact and all its consequences.

Fig. 9. *Scenery of the Flood according to the picture-bible of Doré (1880).*

Fig. 10. *The Flood event, depicted by L. Cranach 1522, illustrates the description of the apocalypse in the revelation of St John (Holy Bible, ch. 6, verse 12–17). The picture shows the shooting stars, the earthquake, the darkness by the eruption dust and the flight of men into caves.*

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Fig. 11. *The Creation according to Moses in Genesis; represented in a baroque edition of Ovid's* Metamorphosis *(lib. 1, fig. 1).*

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