The Extinction of the Dinosaurs

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ABSTRACT

Dinosaur extinction is still a major enigma of Earth history. In this review article, extinctions in the geological record will be briefly mentioned. Many of the imaginative theories for the extinction of the dinosaurs will also be presented. Within the uniformitarian paradigm, the meteorite impact theory, once considered 'outrageous', now is the dominant theory. However, the volcanic theory is still believed by a majority of palaeontologists. Both theories have their strengths and weaknesses. The unscientific behaviour of those involved in the meteorite paradigm change will be briefly explored. Evidence that the dinosaurs died in a cataclysm of global proportions will be presented, such as the huge water-laid dinosaur graveyards found over the Earth. Occasional monospecific bone-beds and the rarity of fossils of very young dinosaurs suggest a catastrophic death and burial. The billions of dinosaur tracks recently discovered provide testimony to unusual, stressful conditions. Nests, eggs, and babies are a challenge to a Flood model, but there are enough unknowns associated with the data that solid conclusions are difficult to draw. The part that impacts and volcanism play in a Flood paradigm will be briefly discussed. The question of whether the K/Tboundary and the extinction of the dinosaurs should be considered a synchronous event within the Flood will be considered.

INTRODUCTION

Dinosaurs bring wonder to children and adults alike. That such great beasts once roamed the Earth is hard to imagine. Even harder to imagine is that some dinosaurs such as *Tyrannosaurus rex* were probably giant killing machines (after the Fall, anyway). Of all the many questions related to dinosaurs, their disappearance from the Earth is the most mysterious of all. (Their demise, of course, assumes that no dinosaurs are alive today, as some people believe, but which is beyond the scope of this review article.)

The mystery is heightened when one realises that the dinosaurs were well adapted to their environments and apparently had a worldwide distribution. Dinosaurs have been unearthed on every continent, including Antarctica.[1,2] Their traces are even found on a few isolated oceanic islands, such as Spitsbergen[3] and North Island, New Zealand.[4] Besides Antarctica and Spitsbergen, dinosaurs have been dug up from other high latitude or inferred high palaeolatitude locations.[5] For instance, they have been unearthed from the North Slope of Alaska near the Arctic Ocean.[68] These high latitude discoveries have initiated many questions on whether dinosaurs were endotherms, ectotherms, or some combination in between; whether they migrated towards lower latitudes to avoid winter cpld and darkness; or if they actually lived at these polar locations all year round.[9] Polar dinosaurs have greatly perplexed uniformitarian scientists, as exemplified in the following comment by Michael Benton:

> *'Should we now imagine dinosaurs as thermally insulated warm-blooded animals that ploughed through snowdrifts and scraped the ice off the ground to find food?'*[10]

During the past 20 years, dinosaur tracks have been discovered at over 1,500 locations from around the world (Figure l).[11] Tracks are even known from polar latitudes, such as in Alaska near the coast of the Arctic Ocean[12] and from the isolated North Atlantic island of Spitsbergen.[13] The number of tracks is in the billions. Some areas display tracks on multiple layers of sedimentary rock.[1416]

Dinosaur eggs, as well as nests, embryos and hatchlings, are now recognised from at least 199 locations around the

Figure 1. *Worldwide distribution of dinosaur footprint discoveries. About 1,500 locations have been known to yield dinosaur tracks.*

world (Figure 2).[17] A new discovery from Spain suggests a whopping 300,000 eggs packed into a rock volume of about 12,000 cubic metres.[18,19] These rocks are probably within marine sandstone, so according to the uniformitarian paradigm the nests are automatically said to have been laid at the seashore. Despite all these eggs, embryos within the eggs are very rare.[20] Characteristics of nests, eggs, and hatchlings in north central Montana, USA, have given rise to interesting interpretations of dinosaur maternal care.[21,22]

Why did the dinosaurs, as well as the marine reptiles and the flying reptiles, vanish from off the face of the Earth? This is the burning question. Although many dinosaurs became extinct well before the End Cretaceous, nevertheless Zhao Zi-Kui indicates that dinosaur extinction still remains a major enigma of Earth history, despite two promising theories:

> *'Thus, the dinosaurs could quickly make use of the available ecological and evolutionary opportunities. However, they all vanished from the earth in the global events at the end of the Cretaceous. The cause poses a difficult question for which no ready answer is apparent.'*[23]

EXTINCTIONS IN GENERAL

Dinosaurs, although creating the most interest, are but one group of animals that became extinct at the end of the Cretadeous (the geological time-scale is used for communication purposes only and is not meant to endorse the geological column or time-scale). Extinctions have also occurred in all other periods of geological time. The subject of extinctions is rather controversial due to

(1) taxonomic difficulties,
(2) the unknown time-stratigraphic range of most species,
(3) the multiplication of names for the same organism, and
(4) the unknown palaeobiogeographic distribution of many taxa.[24]

A few evolutionists actually believe there was no such thing as 'mass extinction'.[25] Many others see a background level of extinction punctuated by nine periods of high extinction rates. Table 1 lists the geological time of these nine mass extinction events and their probable causes.[26]

The most singular extinction event in the supposed history of life was not the End Cretaceous disappearance of the dinosaurs, but the End Permian demise of most groups

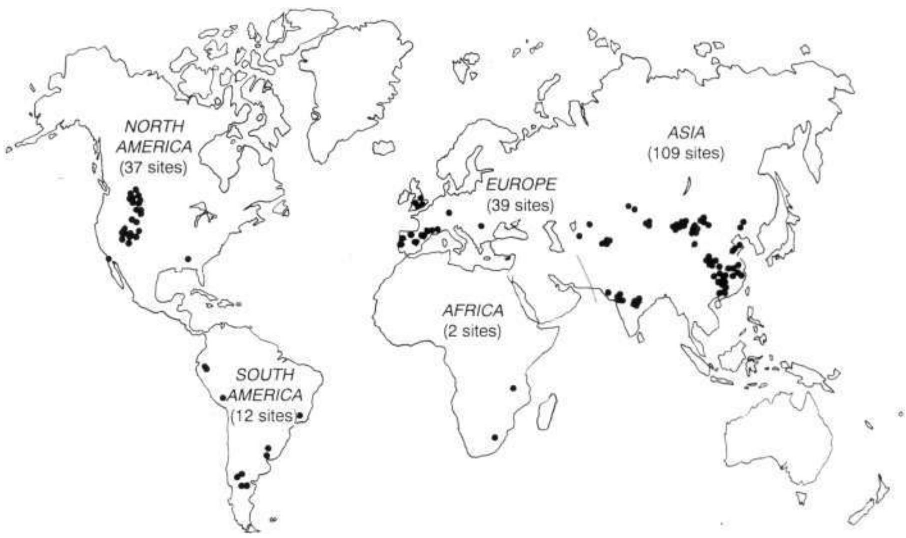

Figure 2. *Worldwide distribution of the 199 sites where dinosaur eggs have been found. Major deposits are few. The fragile eggs were easily broken and then dissolved in groundwater. Most of those that were fossilised go unrecognised by the untrained eye.*

of marine and terrestrial animals.[27] The gravity of this End Permian event varies, depending upon the scientist doing the analysis and upon whether the datum is at the species, genus, or family level. One estimate is that 57 per cent of marine families and 96 per cent of marine species were decimated.[28] Referring to Table 1, this extinction is attributed to cooling from an 'ice age' in combination with a marine regression. However, according to the uniformitarian paradigm the late Carboniferous and early Permian 'ice age' had ended millions of years before[29] and should have caused a marine transgression due to melting ice, at least up until mid Permian time. Recent research is now trying to tie in the massive End Permian time extinctions with a giant meteorite impact, based on the finding of shocked quartz in Australia and Antarctica.[30]

Since geologists love cycles, five of the extinction events in Table 1 motivated David Raup and John Sepkoski to postulate a 26 million year extinction periodicity over the past 250 million years of geological time.[31] One hypothesis for the cycle was that Nemesis, a twin star of the Sun, periodically disturbed the hypothetical Oort cloud of comets, some being ejected into the Solar System.[32] Some of these comets then collided with the Earth, resulting in the periodic mass extinctions. Nemesis has of course never been observed, neither has the Oort cloud. It is interesting that the 26 million year periodicity motivated other scientists to statistically scrutinise terrestrial impact structures, which supposedly 'verified' the 26 million year cycle.[33] Many scientists now dispute the 26 million year periodicity, revealing in the process questionable assumptions in taxonomic analysis:

> *'Patterson and Smith's analysis produced the unexpected result that only a quarter of the families and family distributions recognised by Raup and Sepkoski are valid. The other three-quarters fell into six inappropriate groupings . . .'*[34]

The 26 million year cycle of impact craters is very likely an example of the reinforcement syndrome, in which an hypothesis tends to be supported by further research, when the support really is not there.[35]

THEORIES OF DINOSAUR EXTINCTION

Naturally, such a mystery as dinosaur extinction has spawned a wide range of theories, ranging from the plausible to the entertaining.[36-41] In 1963, a geologist counted 46 theories, and many more have been added since then.[42] Probably only the cause of the Pleistocene ice age has generated as many bewildering theories. (As of 1968, there were 60 theories for the cause of the ice age.[43] In 1957, a prominent ice age specialist, J. K. Charlesworth, summarised ice age theories:

> *'Pleistocene phenomena have produced an absolute riot of theories ranging 'from the remotely possible to the mutually contradictory and the palpably inadequate."* '[44])

Some dinosaur extinction theories postulate that dinosaurs died from the cold, while others suggest the beasts died from the heat, or else it was too hot in the summer and too cold in the winter. One theory hypothesises that the climate became too wet, while another that the climate dried out to kill off the dinosaurs.

EXTINCTION EVENT		SUGGESTED UNIFORMITARIAN CAUSES
1.	Late Pleistocene	Climate warming and predation by man
2.	Eocene/Oligocene Transition	Severe cooling, Antarctic glaciation, and ocean current changes
3.	End Cretaceous	Bolide impact
4.	Late Triassic	Increased rainfall and marine regression
5.	End Permian	Severe cooling, glaciation, and marine regression
6.	End Devonian	Cooling related to widespread anoxia of epeiric seas
7.	Late Ordovician	A Gondwana glaciation
8.	Late Cambrian	Habitat reduction probably caused by marine transgression
9.	Late Precambrian	Marine regression, anoxia, sluggish ocean, biological stress, etc.

Table 1. *Nine major mass extinctions and their suggested cause or causes.*

The dinosaurs could have starved to death or died from overeating. Or their extinction may have been caused by a nutritional problem, such as newly 'evolved' flowering plants not providing the proper nutritional balance. Or the flowering plants could have evolved poisons that killed the dinosaurs, as some theorise. A variant on the poisoning theme is that poisonous insects evolved and stung the dinosaurs into extinction. Others thought the water became poisonous with chemicals. Another ingenious twist is that butterflies and moths evolved and the larvae stripped the plants of leaves causing the herbivores to pass away, bringing on the extinction of the carnivores. Another theory suggests the herbivorous dinosaurs simply changed their eating habits to a less favourable diet, causing the demise of all the dinosaurs. Some postulate that too many carnivores decimated the herbivorous dinosaurs.

Astronomical or geophysical causes have often been invoked, for instance a change in the Earth's gravity, the axial tilt, or a reversal in the magnetic field. Some postulate a sudden bath in cosmic radiation. One theory, reinforced at one time by the iridium anomalies in sedimentary rocks, is that a supernova exploded near the Earth.[45] In this case the supernova would have increased the solar proton flux, which would have broken down the protective ozone layer, allowing ultraviolet radiation to zap the dinosaurs. Or the supernova explosion could have sharply increased cosmic rays.[46] Another imaginative hypothesis claimed that intense volcanism spewed up large quantities of radioactive elements, so that the dinosaurs died of radiation poisoning.

In 1978, it was proposed that a spillover of cold brackish water from an isolated Arctic Ocean caused an ecological chain reaction, first killing off the pelagic plankton and ending with the terrestrial animals.[47] Another terrestrial theory postulated that the land became too hilly. Many palaeontologists favour a regression of shallow seas, which suppressed dinosaur speciation rates and increased extinction rates. The mechanism for this vague hypothesis supposedly was due to competitive interchange between faunas and increased disease vectors.

A variety of theories suggest that either the pressure or some other component of the atmosphere changed to kill off the dinosaurs. One example is a decrease in carbon dioxide; another example is an increase in oxygen given off by too many plants. However, others have suggested oxygen decreased due to a decrease in plankton.[48]

A past popular favourite was that little mammals, waiting for 'the great die-off in order to evolve, advanced dinosaur extinction by eating dinosaur eggs. However, vertebrate palaeontologists generally believe the mammals were too small to have accomplished this feat.[49]

There is a large list of far-fetched to entertaining theories (some possibly suggested tongue-in-cheek), including extinction by parasites, slipped vertebral discs, hormonal disorders, shrinking brains, chronic constipation, over specialisation, inability to change, becoming too large, senility, hyperpituitarism, cataracts, racial senescence (they simply lived long enough), and social problems causing malformations of their bones during growth. Charig lists the following as the most outrageous: poison gases, volcanic gases, meteorites, comets, sunspots, God's will, mass suicide and wars.[50] Interestingly, volcanism, meteorite impacts and cometary collisions are now the major contenders, and I will argue that the real reason is an 'act of God' through the agency of the worldwide Genesis Flood. 'Outrageous' geological theories, for example, J. Harlen Bretz's Spokane Flood as the origin of the channelled scabland in eastern Washington, USA, should not be so freely dismissed.

In spite of the recent dominance of the meteorite hypothesis, scientists continue to add new causes or subsidiary causes for the extinction of the dinosaurs. Some of these recent mechanisms are:

(1) cancer triggered by huge bursts of neutrinos released by dying stars in the Milky Way Galaxy;[51,52]
(2) AIDS;[53] and
(3) hypercanes, super hurricanes that could be triggered by meteorite impacts, causing environmental catastrophe.[54,55]

REVIVAL OF THE METEORITE EXTINCTION THEORY

Ever since 1980, the meteorite hypothesis has swept to centre stage, and a large literature now surrounds it. Back in 1979, the meteorite hypothesis was considered outrageous by many geologists. The turnaround came with the discovery of an iridium (Ir) anomaly at the Cretaceous/Tertiary (K/T) boundary.[56] In thin clay layers (1 cm to several tens of centimetres thick) found at Gubbio, Italy, and at Stevns Klint, Denmark, the contained Ir concentrations were increased 30 and 160 times respectively above background levels. The Earth's crust is depleted in iridium and other platinum group elements, while meteorites are enriched in them. A 10 km diameter meteorite was said to have injected 60 times its mass in pulverised rock into the stratosphere, causing a cooling trend that wiped out about 50 per cent of the biota, including all the dinosaurs. Conversely, others envision the impact caused a sudden, short-term temperature rise, instead of cooling from a 'nuclear winter'-like mechanism.[57] The sudden heating supposedly was caused by an oceanic impact which injected water into the stratosphere producing a 'vapour canopy' effect.

It did not take long to discover Ir anomalies at other K/T sites.[58,60] Currently, there are 103 known K/T iridium anomalies from around the world, mostly in marine sediments either on the bottom of the ocean or on land.[61] As for the frequency of meteorite bombardment, Eugene Shoemaker estimated that the Earth probably was struck 5 to 10 times by meteorites that formed craters greater than 140 km in diameter.[62] So an impact at the K/T boundary is not as outlandish within the uniformitarian paradigm as many first thought. Other scientists using computer climate models reinforced the scenario of disastrous climatological and ecological effects.[63]

The discovery of shocked quartz in eastern Montana, USA, in 1984,[64] and at many other sites around the world[65] since then, is considered further proof of the meteorite hypothesis. Shocked quartz differs from ordinary quartz, in that the crystal lattice has become compressed and deformed by pressure. Under a scanning electron microscope, the quartz exhibits planar striations in one or more directions on a crystal face.

Various other, more minor and equivocal evidence has been adduced in favour of the meteorite/asteroid extinction hypothesis, such as:

(1) a palynological change from ferns to angiosperms in 'continental' deposits;[66]
(2) the existence of microtektites,[67] which are small, droplet-shaped blobs of silica-rich glass;
(3) soot-rich horizons supposedly from global wildfires

caused by the heat of impact;[68]
(4) various isotopic ratios;[69]
(5) various other platinum group elements;[70] and
(6) the discovery of the 'smoking gun' —the Chicxulub structure on Mexico's Yucatan Peninsula.[71]

Thus, the meteorite extinction theory has seemingly been verified by an overwhelming amount of observational data.

THE VOLCANIC THEORY

The triumph of the meteorite theory has come with much dissent, especially from palaeontologists who opted for a volcanic mechanism, often combined with marine regression, to explain the data.[72–75] Even in spite of what seems like impressive confirmation of the meteorite theory and reinforced by the scientific press and news media, the dispute continues.[76] If you read only the evidence for the impact theory, you would be impressed. However, if you read further the evidence for the volcanic theory, you would discover that the meteorite theory is not as well supported as it may seem.

Volcanic adherents point to the evidence of massive volcanism around the K/T boundary, for instance, the 1 million km^3 of Deccan basalts in India and the extensive volcanism in western North America related to the Laramide Orogeny. To them, it is more logical that the dinosaurs died out gradually from all this volcanic activity.

As it turns out, iridium is also associated with volcanism, especially with dust injected into the atmosphere from basaltic extrusions.[77] For instance, the fine airborne particles above an Hawaiian basaltic eruption were found to be highly enriched in iridium, much higher than in the K/T boundary clays at Gubbio and Stevns Klint.[78,79] High iridium has also been associated with other volcanic eruptions and found within volcanic dust bands in the Antarctic ice cores. This fine material is of similar particle size as the K/T boundary clay.

Even shocked quartz has been associated with volcanism.[80-82] Impact supporters counter that this shocked quartz is only weakly deformed compared with the K/T boundary shocked quartz, and that shocked quartz is associated with known impact craters as well as nuclear bomb test sites.[83,84] However, Officer and Page argue that shocked grains are not found at some K/T boundary clays, and some shocked quartz grains are too large to have been transported far by the atmospheric winds.[85] Officer adds that evidence of high-pressure shock is now found within rocks formed by explosions within volcanoes.[86]

Many other arguments are brought forth that favour the volcanic theory and/or are inimical to the meteorite theory, such as:

(1) various elemental ratios, especially arsenic and antimony to iridium;[87]
(2) iridium spread over too thick a vertical interval at the K/T boundary, which supposedly would represent hundreds of thousands of years;[88-91]
(3) clays above and below the K/T boundary not much different from the K/T boundary clay;[92]
(4) survival of some environmentally sensitive plants and animals that should have gone extinct,[93] such as frogs, tropical plants[94,95] and marine plants that require uninterrupted sunlight;[96,97]
(5) iridium spikes and shocked quartz at many other geological times;[98–105]
(6) many extinctions well before the K/T boundary;[106-108]
(7) many missing K/T intervals;[109]
(8) the new discovery of polar dinosaurs that supposedly could withstand periods of cold and darkness;[110,111]
(9) much Cretaceous clay or shale of volcanic origin in North America;[112]
(10) no statistical support for a sudden extinction of dinosaurs;[113] and
(11) the possibility that the Chicxulub structure is not of impact origin.[114]

Because the extinctions near the K/T boundary are believed to be either gradual or stepwise,[115] some impact enthusiasts have backed off and instead have suggested extinctions by multiple comet impacts over a 3 million year period.[116] The main problem with the cometary hypothesis is that comets have a low abundance of iridium.[117] Since relatively small iridium spikes have been found associated with 10 other extinction horizons, some investigators have suggested post-depositional mobility of iridium and other platinum group elements.[118] This mobility also would render ambiguous any elemental or isotopic ratios.

Adherents to the volcanic hypothesis offer good counterarguments to all the arguments used in support of an impact. However, impact enthusiasts counter all the volcanic arguments. There is evidence both in favour of and against each hypothesis.

THE PROCESS OF PARADIGM CHANGE IN SCIENCE

The dinosaur extinction controversy has revealed how a particular subfield reacted to a paradigm change. Before 1980, practically all scientists were strongly biased against the meteorite hypothesis. This strong bent was mostly due to the uniformitarian assumption of historical geology:

> *'Geological sciences have undergone a major shift in paradigms. For two centuries, the tenet of uniformitarianism, encapsulated in the phrase "the present is the key to the past", was the skeleton upon which the history of the Earth was constructed.'*[119]

The meteorite hypothesis severely challenged the uniformitarian assumption.[120] But, the impact enthusiasts had chemical data, instead of speculation. The iridium anomalies could not only be observed, but could be further tested at other K/T sites. The finding of iridium spikes at other K/T boundaries convinced most scientists, although at the time the geochemistry of iridium was poorly known, and still is poorly known in a marine environment.[121]

Eventually, meteorite impacts came to be viewed as part of the uniformitarianism paradigm after all.

Thus the meteorite theory was quickly supported and built up by the scientific press, especially by the journals **Science** and **Nature.** Then the popular press accepted it as fact, followed by most intellectuals.[122] The only group of scientists that were not persuaded were the palaeontologists, except for those who advocated punctuated equilibrium, since the idea of impacts fits nicely into their theory. The palaeontologists had already worked out the order and timing of dinosaur palaeonecrology, and it was a slow evolutionary birth and death. They also did not like 'outsiders' such as 'alien' physicists (Luis Alvarez was a famous physicist who had received the Nobel prize) messing around in their speciality.[123,124] Palaeontologists mostly favour the volcanic theory with marine regression.

So, before 1980 scientific bias was against the meteorite theory, but afterwards it was against all other theories. Scientists, nowadays, barely consider the palaeontologists' arguments, many of them quite good from the uniformitarian standpoint. They simply believe the iridium anomalies and the shocked quartz grains prove the meteorite theory.

An overview of the controversy shows that whether a person accepted or rejected the meteorite theory was greatly preconditioned by his institution of higher learning and his scientific discipline.[125] The peer pressure to conform to the preconceived ideas of one's institution is strong, as Stephen Jay Gould admits:

> *7 think orthodoxy is enormously supported. In fact, I would make an argument — and I think that anyone who argues against this is not being quite honest — that institutions, universities in particular, are very conservative places. Their function is not — despite lip service — to generate radically new ideas. There's just too much operating in tenure systems and granting systems, in judgmental systems — usually older upon younger people* [with] *the pretenure needs to conform.'*[126]

Such strong peer pressure results in what is called by many others a 'bandwagon effect',[127] another name for the reinforcement syndrome. William Glen explains:

> *'The "bandwagon effect", exacerbated by the rapid pace of the mass-extinction debates, was strongly in evidence in this study; it was also documented* in vivo *in studies of the accretionary-terrain research program . . .'*[128]

Biases were so strong that scientists resorted to many unscientific ploys to get their personal way, such as verbally attacking one another; using polemics to push their preferences, sometimes using outdated data; refusing to publish key data; and refusing grants for research they did not agree with.[129130] An after-the-fact study by William Glen indicated that few, laymen and scientists alike, really knew much about the issue.[131] This is a sad state of affairs within science — it is no different when it comes to the creation/evolution controversy.

EVIDENCE THE DINOSAURS DIED ' IN A GLOBAL FLOOD

Despite the popularity of the meteorite theory, many scientists believe the extinction of the dinosaurs has not been solved, or else that the meteorite theory needs a secondary, boosting mechanism. The extinction of the dinosaurs is still a major mystery. Gregory Paul exclaims:

> *'The history of the dinosaurs is marked by remarkable success and stability during the Mesozoic. Far from being inherently vulnerable, the dinosaurs survived in spite of repeated changes in sea level and climate, enormous volcanic eruptions, and great impacts. Indeed, the dinosaurs 'fecundity makes it hard to see how such resilient animals could ever have been killed off. The extinction of the dinosaurs was probably not part of the normal course of evolutionary fluctuations, nor was it just another result of random extraterrestrial disruptions. Instead, it remains one of the most extraordinary and inexplicable events in Earth history.'*[132]

Could the reason the extinction of the dinosaurs remains such a major mystery be because of the uniformitarian bias within historical geology?

A Watery Cataclysm and Dinosaur Graveyards

For most creationists, the extinction of the dinosaurs, as well as other extinctions, is not a mystery. In fact, the extinction of the dinosaurs and many other creatures has an easy answer — they simply died in the Genesis Flood (except those dinosaurs likely taken on the Ark, which probably died soon after the Flood). Genesis 7:21,22 states:

> 'And all flesh that moved on the earth perished, birds and cattle and beasts and every swarming thing that swarms upon the earth, and all mankind; of all that was on the dry land, all in whose nostrils was the breath of the spirit of life, died.'

Although there are still many unknowns associated with the observed fossil data on dinosaurs, and the information that is available is often incomplete and interpreted within the evolutionary/uniformitarian paradigm, much of what is known so far fits quite well within the Flood paradigm.

The most obvious aspect of dinosaur fossils is that most dinosaurs must have been buried rapidly in water. Alternately, the dinosaurs could also have been entombed in giant mass flows. Based on the random mixing of charcoalised wood with sand found in Colorado and north-eastern Wyoming, Edmond Holroyd provides evidence for at least region-wide catastrophic debris flows associated with dinosaur remains.[133-135] Furthermore, after burial fossilisation must have proceeded rapidly under special conditions in which minerals moving through the saturated sediments replaced the organic matter. Therefore, it is no surprise that water is closely associated with the burial and fossilisation of the dinosaurs. Clemens states that organisms must be buried rapidly by rare (in his mind 100-year or

500-year events) floods in order to be preserved as fossils.[136] The largest dinosaurs must have been buried by even 'rarer' floods.

A sizeable number of dinosaurs were entombed in obvious marine sediments.[137-139] In assumed terrestrial sediments (the equivocal environmental designation of a terrestrial environment will be briefly discussed later), mainstream scientists commonly interpret the action of water as 'fluvial'. For diluvialists, the dinosaurs could have been buried either by sheet flow or channelised flow; either one is possible in a global Flood depending upon many variables.

Dinosaurs are often found in large bone-beds or dinosaur graveyards, where many dinosaur bones are packed together. This provides evidence for at least catastrophic local floods.[140-142] A few of these bone-beds contain thousands of dinosaurs and indicate catastrophic action. Probably the largest bone-bed in the world is located in north-central Montana, USA. Based on outcrops, an extrapolated estimate was made for 10,000 duckbill dinosaurs entombed in a thin layer measuring 2 km east-west and 0.5 km north-south.[143,144] The bones are disarticulated and disassociated, and are orientated east-west. However, a few bones were standing upright, indicating some type of debris flow.[145] Moreover, there are no young juveniles or babies in this bone-bed, and the bones are all from one species of dinosaur. Horner and Gorman describe the bone-bed as follows:

> *'How could any mudslide, no matter how catastrophic, have the force to take a two- or three-ton animal that had just died and smash it around so much that its femur — still embedded in the flesh of its thigh — split lengthwise?'*[146]

A cataclysmic event obviously is implied.

Another bone-bed containing thousands of duckbill dinosaurs, mostly in a single layer, is found in north-eastern Wyoming.[147] Over 90 smaller bone-beds make up the huge deposit in Dinosaur Provincial Park, Alberta, Canada.[148-150] Dinosaur National Monument in Vernal, Utah, USA, is world famous for its display of a water-laid jumble of disarticulated dinosaur bones.[151] Another well-known bone-bed, mostly of large carnivores, is Cleveland-Lloyd Dinosaur Quarry in central Utah.[152] Colbert described the stacked dinosaur bones in Howe Quarry, Wyoming, USA as being '. . .*piled in like logs in a jam.*'[153] Robert Bakker can't help but think of a cataclysm when viewing the dinosaur graveyard at Como Bluff, Wyoming:

> *'Anyone who cherishes notions that evolution is always slow and continuous will be shaken out of his beliefs by Breakfast Bench* [Como Bluff] *and the other geological markers of cataclysm.'*[154]

There are many other dinosaur graveyards in western North America, practically all, if not all, indicating catastrophic burial by water or aqueous slurries.

Dinosaur graveyards are not found just in the western United States, but worldwide. One of the first graveyards discovered was an Iguanodon graveyard in Belgium.[155] A new sauropod graveyard has been discovered in Niger, Africa. This graveyard is dated as 'Cretaceous', even though the dinosaurs closely resemble 'Jurassic' dinosaurs of western North America and are dissimilar to dinosaurs from South America, which was expected according to the theory of plate tectonics.[156] A dinosaur graveyard of well-preserved, articulated dinosaurs is now being excavated at Dashanpu, China.[157]

Another dinosaur graveyard that has recently made the scientific news is in Mongolia, also known for its many dinosaur eggs. This is one of the few graveyards that some scientists believe was buried, not by water, but by 'catastrophic' sandstorms.[158,159] Just recently a 'brooding' oviraptorid was found on top of fossilised eggs in Mongolia.[160] David Weishampel says that what these dinosaurs ate in the desert is a problem. Moreover, the unique preservation of a brooding dinosaur

> '. . . *owes a great deal to rapid death and burial in what must have been a powerful sandstorm, so sudden that we are left with the impression of an animal freeze-framed in the act of nest brooding.*'[161]

It is doubtful a sandstorm could freeze-frame a brooding dinosaur. Usually any little disturbance will cause an animal to leave its eggs. There is the added question of how the dinosaurs are to be fossilised in a desert. It is more likely this powerful sandstorm was a 'giant watery sandwave' in a catastrophic flood.

Similar to the huge bone-bed in Montana,[162,163] many of these dinosaur graveyards contain only one or mostly one type of dinosaur.[164] Practically all the bones in these monospecific bone-beds are disarticulated and broken.[165] Furthermore, babies and young juveniles are not only missing from monospecific bone-beds, but are extremely rare as fossils anywhere:

> *'Except for nesting horizons, baby dinosaur remains are extremely rare in the fossil record, suggesting that most, if not all, baby dinosaur mortality occurred in the nesting area.'*[166]

Since dinosaurs lay many eggs, based on the number of eggs found in nests and clutches, and because infant mortality is normally high in animals, there should be many more fossils of babies and young juveniles than older juveniles and adults. In referring to dinosaur fossils worldwide, Horner and Gorman state:

> *'As succeeding years yielded no other major finds of baby dinosaurs, the question grew in importance. If you think about it,. . . more dinosaurs should have died young than died old; that's what happens with most animals. And the high infant mortality should have produced a lot of fossils over the course of 140 million years — a lot of fossils that had never been found.'*[161]

The pervasive lack of very young dinosaurs and the occasional monospecific bone-beds of broken and disarticulate bones is most unusual. Some type of herding behaviour is normally invoked to explain monospecific bone-beds, although the stratigraphic character of some bone-beds does not favour this hypothesis. The lack of young juveniles in the monospecific bone-beds is perplexing, because young dinosaurs should have accompanied older dinosaurs in a herd, as observed in herds of animals today. The character of these bone-beds has given rise to a number of speculative theories, including local catastrophes. One would expect that local catastrophes, such as a flash flood or a volcanic eruption, would entomb more than just one type of animal.

Could these monospecific bone-beds containing older juveniles and adults provide further evidence of a unique watery catastrophe? One would surmise that during the initial onslaught of the Genesis Flood, adult and older juveniles would have been better able to flee the encroaching Flood waters. Dinosaurs of the same species may then have herded up, when normally they do not, only to be later buried together. Herding behaviour during times of stress is observed today among elk during cold, stormy weather; cattle before earthquakes; and many other species. The herding in this case would have nothing to do with 'gregarious behaviour' as some evolutionists surmise. Is it possible the reason for the rarity of baby dinosaurs outside nesting areas is because they could not keep up with the fleeing herd and perished quickly. Their bones were not fossilised probably because they were too fragile.

The existence and characteristics of dinosaur graveyards not only provide strong support for the Genesis Flood, but also tell us a few details of what occurred during that great cataclysm. For instance, some bone-beds, especially those in Montana and southern Alberta, show signs of exposure on land for a while following death. This is indicated by the remains of carnivorous dinosaur teeth, and only teeth, found among the bones, as well as tooth marks incised onto the bones.[168-171] In other words, these bone-beds were scavenged, which has given rise to the idea that *T. rex* was just a scavenger. Since the bone-beds are lying on thousands of metres of Flood sediments, it seems reasonable that the Flood sediments became temporarily exposed during the Flood.[172] Flood sediments could be exposed by either tectonic uplift or the falling of sea level due to the dynamics of ocean currents on a relatively shallow, flooded continent.[173]

Dinosaurs Fleeing the Encroaching Flood Waters

Dinosaur tracks also provide more details on unusual conditions during their formation. The importance of dinosaur tracks is that they represent live animals, so that in a Flood model, the tracks were made within the first 150 days of the Flood.[174175] In the western United States, billions of dinosaur tracks have recently been discovered.[176-178] Of special note are the megatracksites. One megatracksite in south-east Utah is on the upper boundary of the Entrada Sandstone, a supposedly desert sandstone. All the tracks are from a fairly large, carnivorous theropod. It is indeed strange that one type of dinosaur lived in a large area of an alleged desert. What were they supposed to eat in a desert? The evidence could be better interpreted as a group of theropods embarking on a temporarily exposed sandy surface during the Flood. Since tracks must be buried rapidly within a matter of days or weeks to be preserved,[179] the sandy exposure was brief, followed by another depositional event.

A 'dinosaur freeway' has been discovered that stretches from north-east New Mexico to north-west Colorado. The tracks are generally of two types and are found on multiple stratigraphic levels that supposedly span several million years. Since the strata containing the tracks are probably conformable, it does not seem reasonable that only two types of dinosaurs used this 'freeway' over several millions of years. It is more reasonable that dinosaurs found a linear strip of land (or a series of shoals separated by shallow water) during the Flood while the sea level was oscillating and sediments were being deposited.

There are also a number of features of the tracks that not only are better understood within a diluvial model, but also tell us some of the unique events that occurred during the Flood. First, the tracks are practically always found on bedding planes,[180] generally capping sedimentary units, which suggests a cycle of sedimentation during the Flood followed by a brief exposure above the water. Why wouldn't the tracks be found throughout the beds if the sediments were deposited slowly over long periods of time?

Second, the lack of relief on the track-bearing strata[181] indicates a rapid sedimentation event forming flat strata over a huge area. Otherwise, erosion over millions of years would have produced at least hilly topography and, therefore, tracks would traverse up and down hills.

The dinosaur-bearing Morrison Formation in the western United States (assuming all the many outcrops are time equivalent, which is questionable) represents what must have been a thin, flat plain a little above sea level. This plain covered 1,800,000 km^2 from central Utah east to central Kansas, and from central New Mexico north to the Canadian border. The description of this Morrison 'peneplain' seems unreasonable:

> *'The enormous area covered by Morrison sediments and the general thinness of the sedimentary sheet (being in most areas less than 100m in thickness) indicate that the sediments were distributed by widespread, flowing water.'*[182]

I can believe the widespread flowing water part, but did this flowing water excavate channels and valleys or create unconformities over a long period of time? The evidence for fluvial action is almost nonexistent:

> *'Given the flat surface over which the Morrison was deposited. . . the absence of evidence for major single channel systems. Lack of initial valley incision into the surface left by the retreating seas, and the absence of unconformities within the Morrison . . .'*[183]

How can sediments be deposited thinly and evenly by rivers over a huge, flat surface with little slope without leaving significant channels? Such a flat plain containing both dinosaur tracks and remains is most unusual: *'Nothing on earth today closely resembles the environment of the Morrison Formation.'*[184] Indeed, the observations of the 'Morrison Formation' bear striking evidence for catastrophic sheet flow, and not slow processes over millions of years.

Third, unusual, stressful conditions are also indicated by the fact that practically all trackways are straight.[185] Lockley and Hunt state: *First, the sauropod was changing direction, turning to the right, a phenomenon rarely recorded in trackways.'*[186] Any deer or elk hunter knows that land animals frequently meander, especially while looking for food. Straight tracks are usually made when the animal is in a hurry, escaping a predator or a hunter, or rapidly migrating. Even in these situations, the trackways will sometimes curve or meander a little. The fact that practically all dinosaur trackways are straight strongly favours animals desperately trying to escape some catastrophe. The worldwide extent of these straight dinosaur trackways provides evidence for a cataclysm of global proportions.

Fourth, there are very few tracks of babies or juveniles.[187,188] Coombs states:

> *'As with bones, footprints of juvenile dinosaurs are quite rare . . . but this apparent scarcity may be in part an artifact of taxonomic bias.'*[189]

Regarding this claim of taxonomic bias, it is interesting that 50 per cent of the elephant tracks from Amboseli National Park, Africa, were made by juveniles.[190] Although elephants probably grow much slower than dinosaurs grew, and it can be difficult recognising a small track, dinosaurs are expected to have produced many more babies than elephants. So the reasons for the rarity of tracks of both babies and juveniles is not in accord with observations from the modern world, and hence it is against the uniformitarian principle that guides geological thought. The lack of tracks of young dinosaurs fits better into the Flood model, in which babies and juveniles were less able to flee the encroaching Flood waters and hence were unable to make too many tracks.

Fifth, another uniformitarian puzzle that is better explained within a Flood paradigm is the nearly complete absence of tracks of stegosaurs, ankylosaurs and ceratopsians, although they are certainly heavy enough to make tracks and their skeletal remains are common.[191] Their thick armour and large bony plates suggest they were poor swimmers (in the track record, there is evidence of swimming dinosaurs and dinosaurs making tracks in shallow water[192-194]) and so they probably succumbed to the first inundation of their habitat.

In summary, all these unusual characteristics of dinosaur tracks do not fit into the uniformitarian paradigm of slow, gradual processes over millions of years. The evidence fits better a time of worldwide stress on dinosaurs trying to escape rising Flood waters. Since the tracks were made on hundreds to thousands of metres of Flood sediments, the evidence, as With bone-beds, indicates briefly exposed sediments or shallow water during the period of rising Flood waters.[195] Track layers on more than one bedding plane represent brief exposures during a generally, continuous sedimentation event. The oscillations in local sea level would have been caused by local or distant tectonic events, tides, the dynamics of the Flood currents,[196] tsunamis, etc.

CAN DINOSAUR NESTS, EGGS, AND BABIES BE EXPLAINED WITHIN THE FLOOD?

The hypothesis of exposed Flood sediments during the early stages of the Flood is further supported by dinosaur bone-beds and tracks. It is expected from this hypothesis that pregnant female dinosaurs would have laid eggs on these temporary refuges. So, the finding of fossilised dinosaur eggs, sometimes in nests, which have recently been discovered in many parts of the world,[197] is not unexpected. However, of the thousands of fossilised dinosaur eggs discovered, only several contain embryos,[198] and most of these have been discovered in north-central Montana and southern Alberta.[199-201]

Several features of the nests, eggs, and babies appear to contradict the above Flood model; it seems as if too much time was required for all the indicated dinosaur activity[202-204] For example, at a few locations, eggs have been found at two or three stratigraphic horizons, for instance, at three levels within a 3 m vertical section on Egg Mountain.[205] It also has been reported that 15 baby Maiasaurs, found in and around a nest 1 km north of Egg Mountain, north-central Montana, had grown for a while.

Before discussing this subject, the reader must be aware of the many unknowns associated with dinosaur eggs, which are subject to variable interpretation by mainstream scientists. Much of the detailed information has not been published. What at first may seem contradictory to a Flood model, may be shown not to be discrepant with further data. For instance, the 15 Maiasaur babies believed to have partially grown had worn teeth, some teeth three-quarters worn.[206] At first glance, these worn teeth suggest the babies had fed for a relatively long period with the help of attendant mother dinosaurs. Garner states in referring to these worn teeth: *'It is difficult to see how this sequence of events can be accommodated within the year of the Flood.'*[207] An alternative explanation is that the babies wore down their teeth while in the eggs and need not represent a long time of feeding. Based on the analysis of embryos near the Montana/Alberta border, Horner and Currie have concluded that embryos ground their teeth **while still in the egg.**[208,209] (For the baby dinosaurs, worn teeth would have been no problem, since the teeth would have been simply replaced by new teeth.) Therefore, data on dinosaur eggs that at first seem inimical, may still be explained within a Flood model after further information is published.[210,211]

With the above example in mind, let us take a cursory view of Egg Mountain and vicinity. In north-central Montana and southern Alberta, there are several claims for nests, eggs and babies at multiple stratigraphic levels. However, in one instance the 'different levels' are many tens of kilometres apart.[212,213] Since outcrops are isolated, the stratigraphy could easily be a little confused, due to facies changes or erosion that could have stripped more strata from one area than the other. In these cases, the eggs could be at the same time horizon.

On Egg Mountain, it was earlier published that eggs of hypsilophodont dinosaurs, *Orodromeus makelai*, were laid on three separate horizons within a 3 m thick vertical section. The eggs were half embedded in limestone layers between mudstone.[214] Just having eggs at different stratigraphic levels is really not a problem in a Flood paradigm, in which portions of exposed land were periodically inundated.[215] (It would be the same mechanism for the formation of multiple dinosaur track layers.) For example, turtles lay their eggs within hours in beach sand and then leave them. Conceivably, a fluctuating sea level could bury their eggs with more sand, and then re-expose the beach for more turtles to lay their eggs soon after the first group.[216]

However, palaeontologists believe that many of the eggs hatched. Support for this argument comes from the observation that many eggs have broken tops, and that 20 to 25 juveniles of various sizes were found within the nesting area on the horizons.[217] Garner accepts this evidence at face value, concluding that a long period of time was required:

> *'Thus nest construction, egg-laying and nurture of juveniles occurred at this locality three times. If one cycle of this sort is difficult to fit into the Flood year, the establishment of three successive nesting colonies one after the other surely strains the imagination, notwithstanding that the growth of baby dinosaurs was rapid'*[218]

Actually, nests on Egg Mountain are rare; the eggs were mostly laid in a spiral on limestone with the pointed end down.[219,220]

There is new information and several observations that suggest that there is more to the story of what happened on Egg Mountain. First, there is some question on the number of horizons with anywhere from two to four suggested.

Second, the dinosaur eggs are no longer considered hypsilophodonts, but the theropod *Troödon.*[221,222] This mistake was easy to make at the time since there was little skeletal material of *Troödon* and the bones of each are similar in many ways. There are eggs from a second type of dinosaur called *?Troödon,* which is not *Troödon* but from an unknown species. The 20 to 25 partial dinosaur skeletons at Egg Mountain are still considered *Orodromeus,* but they had **not** been hatched from the egg clutches, which are now *Troödon* eggs.

Third, the eggs may or may not have hatched. Just because the tops of many eggs were broken, does not necessarily mean the dinosaurs hatched. There are other possible explanations for this observation. Broken egg tops could have been caused by erosion from the next sediment layer or by compaction of the sediments. The tops of the eggs could have been Broken by scavengers, for which there is abundant evidence in the area. There are fossils of small mammals, varanid lizards, pterosaurs and other types of dinosaurs at Egg Mountain.[223-226] *Troödon* teeth are abundant at Egg Mountain.[227] *Troödon* teeth are commonly associated with eggs at other sites of north-central Montana and southern Alberta.[228,229] Could *Troödon* have cannibalised its own eggs on Egg Mountain, as is suggested for *Coelophysis* from the dinosaur graveyard at Ghost Ranch, New Mexico?[230] Teeth of *Albertosaurus,* very similar to *T. rex,* also are found at Egg Mountain.[231] Skeletons of 20 to 25 young dinosaurs are scattered among the eggs.[232] Could they have scavenged the eggs? All this evidence suggests the eggs may have been scavenged after being laid, which need not take a long period of time on exposed land during the Flood.

Although the stratigraphy of the Maiasaur nesting area, 1 km north of Egg Mountain, is confused due to a high degree of lateral variability,[233] three stratigraphic levels are claimed.[234] Eggs are believed to have been laid at the top and bottom horizons, but not vertically above each other. Local erosion or soft sediments while the sediments were briefly exposed during the Flood could account for eggs on two of three stratigraphic horizons. In other words, it is possible that the dinosaurs laid eggs on a surface that cuts through the stratigraphy.[235]

One horizon contains eight closely-spaced 'nests', two that contained hatched baby dinosaurs. This is the horizon where 15 babies were found associated with a nest-like structure, 11 babies inside and four around the perimeter. The skeletons are lm long. The ones in the 'nest' were disarticulated and jumbled together, a rather unusual condition for babies that supposedly died in a 'nest'. One of the other eight 'nests' contained babies only 0.5 m long. Babies 0.5 m long were also found outside the 'nests'.[236] So, it appears that the 1 m long babies in the 'nest' grew for a while, suggesting mothering dinosaurs. Horner believes they grew rapidly and reached 1 m in length in about one month. It is possible that during the first 150 days of the Flood the Maiasaurs laid eggs and that the babies hatched and grew to 1 m long.

However, the idea of mothering dinosaurs for altricial babies has recently been challenged.[237] If this claim is true, the mothers did not need to care for their young. Then what were the 15 babies each 1 m long doing in and around one of the 'nests'? If eight duckbill dinosaurs made nests at the same time, which the evidence suggests, why are some babies only 0.5 m long and some 1 m long? Is it possible that multiple-sized babies were hatched at the same time? Are the claimed nests really nests made by mothering duckbill dinosaurs? They appear to be so, but other explanations are possible, especially in view of the possibility that baby Maiasaurs were precocial. At this point, whether the baby Maiasaurs were precocial or altricial is controversial. There are still too many unknowns to answer these questions.

There are several other indications of unusual, stressful conditions associated with fossilised dinosaur eggs. However, not enough study has been devoted to these conditions to know whether these were general or isolated occurrences. I will only briefly mention them. There are a number of reports of extremely thin egg shells.[238-240] Pathological eggs, especially with multiple shell layers, have also been reported.[241-245] Pathological eggs are rather rare in western North America compared to other areas of the world.[246] It is rather strange that of the thousands of eggs recently discovered, embryos within the eggs are extremely rare.[247,248] Palaeontologists believe the reason for this rarity is because the egg contents are not preserved:

> *'Fossil experts think that normally egg contents leak, or decompose until the bones dissolve, or are eaten by predator dinosaurs before fossils are formed.'*[249]

Further data may indicate whether the above observations of fossilised dinosaur eggs are general or rare. If general, they would indicate unusual conditions; if rare, they probably would be the result of chance.

VOLCANOES AND METEORITES DURING THE FLOOD

The adherents of the meteorite theory and the volcanic theory for the demise of the dinosaurs possess both supportive and contrary data. The contrary data indicate that neither mechanism is the full story.

Creationists expect the Flood to have been a volcanic, tectonic, and hydrological cataclysm. Both submarine and subaerial volcanism is expected, and indeed there is abundant evidence for volcanism in both Precambrian[250] and Phanerozoic[251] sedimentary rocks. In Montana, Wyoming and southern Alberta, the dinosaur-bearing beds contain copious amounts of volcanic material. So volcanism could easily be associated with the demise of the dinosaurs during the Flood, but not the main cause.

However, it is very likely that meteorite impacts also occurred during the Flood. Jeremy Auldaney suggests that impacts triggered the Flood.[252,253] Carl Froede and Don deYoung propose that a planet broke up between Mars and Jupiter, based on the Titius-Bode relationship. The debris from this breakup was responsible for the cratering observed in the Solar System, with most impacts on Earth occurring during the Flood.[254] These authors are probably correct, since both the pre-Flood and post-Flood time-frames are expected to have been times of relative geological quiet.[255] Furthermore, there are around 150 probable impact craters now known on Earth.[256] Most of the impact craters are dated between 1 million and 1 billion years.[257] One would expect that most of these 150 impacts occurred during the Flood, especially if the Flood/post-Flood boundary is generally in the late Cainozoic of the uniformitarian time-scale.[258-260] The reason for this deduction is that erosion since the Flood has been slight, especially in areas not glaciated.[261] An impact within the Flood is expected to have been greatly eroded and filled with sediment, showing just the bare circular outline, with little or no detectable ejecta. On the other hand, a post-Flood impact is generally expected to exhibit relatively sharp features plus ejecta, especially in a non-glacial and dry environment. A classic example is the Arizona Meteor Crater.[262] Therefore, since most impact craters are barely detectable in the Flood sediments, it is likely that most impacts occurred during the Flood.

The largest iridium anomalies are probably due to impacts. This is because volcanically-produced iridium is mainly from basaltic eruptions, which probably were underwater eruptions during the Flood.[263,264] Either way, multiple impacts and volcanic eruptions would explain the evidence of the many iridium anomalies, shocked quartz grains, tektites, etc. found in the geological record. The rapid sedimentation during the Flood would explain the observation that an iridium 'spike' can be composed of **multiple** spikes or else **spread over more than a thin layer of sediment.** Uniformitarian geologists date such relatively thick layers as lasting hundreds of thousands of years, but within the Flood an iridium-rich layer would be only an instant of time. Iridium-rich clay falling from the atmosphere would probably accumulate during temporary lulls in the Flood. The clay could fall rapidly due to coagulation of particles. Accumulations of iridium-rich clay would be unlikely at the beginning of the Flood, but more likely during the middle or end of the Flood. This is because of the rapid erosion and sedimentation likely at the beginning of the Flood.

The fact that few extinctions occur right at the exact K/T boundary bodes ill for the meteorite theory. There are only 20 locations where dinosaurs are even close to the K/T boundary, as defined by an iridium anomaly or some other fossil criterion:

> *'In the case of the Cretaceous-Tertiary boundary, many people — even professionals — are very surprised to discover that there are only about 20 localities, most of which are in North America, that preserve the last days of the dinosaurs.'*[265]

If most dinosaur extinctions are not associated with an Ir anomaly, then how could impacts have been the main cause for the death of the dinosaurs?

In a Flood model, the problem of the survival of certain sensitive organisms across the K/T boundary is not a problem, mainly because that 'boundary' is nothing special within the Flood paradigm and probably is not synchronous. The new discovery of polar dinosaurs is a problem for the meteorite theory, but can be explained within the Flood paradigm.[266]

IS THE K/T BOUNDARY SYNCHRONOUS?

All the hypotheses of dinosaur extinction assume that many dinosaurs, ammonites and other groups of organisms died out near the Cretaceous-Tertiary boundary. But is the K/T boundary, especially in relation to the extinction of the dinosaurs, a synchronous event worldwide within the Flood? It probably is not even a synchronous event within the uniformitarian paradigm.

The definition of the K/T boundary varies in different parts of the world, depending on whether the strata are presumed marine or terrestrial and depending upon which fossils are found in the strata. Defining a terrestrial or marine environment can be challenging and is normally based on the fossils. Many terrestrial fossils could have been buried in marine environments, especially within a Flood paradigm and even within a uniformitarian paradigm. For instance, a classical late Cretaceous dinosaur site in eastern Montana is considered a terrestrial environment. However, shark remains are also found. Since dinosaurs and coal are abundant, the shark remains are relegated to having lived in a 'freshwater' habitat,[267] even though sharks are marine today and it seems impossible physiologically to assign extinct sharks to a freshwater environment. In the Flood model, the observation of shark remains among dinosaurs would not be considered unusual, since one would expect that sharks would scavenge floating dinosaurs and occasionally end up entombed with dinosaurs.

The K/T boundary was first defined as changes in fossil marine biota in rocks of northern Europe.[268] Nowadays, the fossil dating method is so refined that each micro-organism, whether a diatom, foraminifer, coccolith or radiolarian, has its own boundary-defining criterion. Some have claimed the definition of the K/T boundary based on these microfossils is rather subjective,[269,270] and when the particular fossil is absent, a hiatus is presumed.[271]

Even the classical marine K/T section with a large Ir spike at Gubbio, Italy, is not without controversy. One geologist, after careful research, concluded that the section was a reworked Miocene turbidite.[272] This idea was published after the section had been touted as a K/T impact horizon. Nevertheless, Alvarez and Lowrie[273] jumped all over this result and prevailed. It seems that reworking is mainly invoked to support the prevailing paradigm. The K/T boundary at Gubbio is of reversed palaeomagnetism, so the K/T boundary in other areas also has to be reversely magnetised. However, at least one ocean core at the supposed K/T boundary was found to be normally magnetised.[274] These two K/T boundaries are thus probably not synchronous.

For presumed terrestrial sediments, the boundary had been universally defined as the last appearance of the dinosaurs:

> *'Critics charged that Rigby and his colleagues didn't know exactly where the end of the Cretaceous was in the sediments that they were studying; after all — it was pointed out — the end of the Cretaceous was commonly recognised as the place where the last (youngest) dinosaur was preserved.'*[275]

However, defining the K/T boundary on the basis of the 'youngest' dinosaur fossil in a vertical section is a poor criterion, when only about 20 dinosaur localities from around the world are close to this boundary.[276]

Defining the K/T boundary based on the last dinosaur is also a circular definition, since scientists claim that the dinosaurs only lived in the Mesozoic when the presence of a dinosaur **automatically defines** the strata as Mesozoic. For instance, dinosaur remains from France and India were discovered in what were considered 'Tertiary' strata. The strata were subsequently redefined as 'Cretaceous'![277,278]

In eastern Montana, there is a controversy over whether dinosaurs lived into the Tertiary. The K/T boundary in this area is defined by a floral change, but it is also associated with a weak iridium anomaly (an original report of a significant Ir anomaly turned out to be contamination from a platinum ring worn by a technician preparing the samples for analysis[279]). Dinosaurs have been found above the defined K/T boundary from at least six sites, while ungulates, normally considered 'Tertiary', have been found below the boundary.[280-282] Dinosaurs are also said to have survived well into the Palaeocene in other areas, such as the tropics of India, the Pyrenees, Peru and New Mexico.[283] Of course, the data from Montana have been strongly contested with the suggestion that reworking had mixed the fossils.[284] Reworking is a common mechanism for accounting for fossils in the wrong strata,[285,286] preserving a semblance of order in the slow evolution of organisms with time. In spite of claims of reworking, Keith Rigby and his colleagues are sticking to their claim of Tertiary dinosaurs.[287] Despite the merits of the various arguments, the circular reasoning is evident.

Another K/T defining criterion for a presumed terrestrial environment is a change in certain pollen or spores. In eastern Montana, the K/T boundary is also defined as the base of the Z coal layer. But some geologists believe this coal bed is diachronous, which would mean this definition of the K/T boundary is subjective.[288] The problem for defining the K/T boundary in eastern Montana is compounded due to the many coal beds and the scattered nature of the outcrops.

All the many definitions of the K/T boundary are difficult to reconcile with each other into a worldwide synchronous time horizon within the uniformitarian paradigm:

> *'Even given the entire fund of techniques, methods, and principles of correlation extant, there was still, in the past decade, widespread uncertainty about correlating marine rocks of K/T boundary age with their continental contemporaries, even where both sections were richly fossiliferous, because the two sections were almost always mutually exclusive in time-diagnostic fossils'*[289]

That the K/T boundary from various areas is asynchronous is also admitted by Olsson and Liu:

> *'Examination of recently reported K/P* [K/T] *boundary sections indicates that the placement of the K/P boundary is based on equivocal criteria and that the boundary as placed is not synchronous. The conclusion that the K/P boundary in several U.S. Gulf Coast sections is complete and within a condensed section is simply the artifact of delineating the K/P boundary on disparate paleontologic datum planes and preservational bias of the microfossil assemblages.'*[290]

And in correlation of widely scattered outcrops, there is the common problem of lateral facies and fossil changes that can cause uncertainty even in local and regional correlations.

Defining the K/T boundary as the last appearance of a particular fossil, a common procedure, is a dangerous exercise. This is because fossils have a habit of disappearing vertically at one location and reappearing at a 'higher level' at another location. This has been labelled the 'Lazarus Effect'.[291,292]

Even though the various fossil definitions of the K/T boundary are asynchronous, could an Ir anomaly be used to define a synchronous K/T boundary, whether in a uniformitarian or a diluvial paradigm? The problem here is that there are many Ir anomalies in the strata, and many of the spikes at the 'K/T boundary' are weak or non-existent. In regard to dinosaur extinction, few dinosaur localities are even close to the defined K/T boundary, and even fewer are close to a significant Ir anomaly. There is also the problem that the K/T boundary is sometimes 'defined' by the Ir spike,[293-295] introducing an element of circular reasoning.

Although palaeontologists believe most of the age differences between various defining fossils are minor, it underscores the subjective nature of the process and some of the problems in choosing the 'K/T boundary'. The various K/T boundary defining criteria, as viewed by uniformitarian scientists, are probably asynchronous. Therefore, creationists should not assume the 'K/T boundary' and the extinction of the dinosaurs is a synchronous event within the Flood.

SUMMARY AND CONCLUSIONS

Despite the many theories on dinosaur extinction, including the currently popular meteorite impact theory, the demise of the dinosaurs is still unexplained. Wherever dinosaur bones are unearthed, the evidence predominantly suggests catastrophic entombment by water, sometimes by clearly marine water. Just the burial and fossilisation of such massive hulks as the large dinosaurs indicates catastrophic action. There is also evidence that some dinosaurs were rapidly buried in at least regional debris flows. The large dinosaur bone-beds especially indicate a major catastrophe. Some of these bone-beds represent the remains of one dinosaur species, an unusual taphonomic condition. Babies and young juveniles are almost entirely missing as fossils, another enigmatic occurrence for those who assume uniformitarianism.

Billions of dinosaur tracks have recently been discovered, and these provide further evidence for unusual, stressful conditions. For instance, the tracks do not traverse hills, they are practically always orientated in a straight line, there are very few tracks of baby dinosaurs, and some dinosaurs that may have been poor swimmers are nearly absent. It is suggested that dinosaur tracks and remains could have occurred during temporary exposure of sediments during the first half of the Flood.

Dinosaur eggs, nests, and babies at first glance appear to contradict the hypothesis of briefly exposed sediments during the Flood. However, many unknowns still surround this fascinating evidence of *in situ* dinosaur activity.

The volcanic and meteorite theories for dinosaur extinction have both supportive and contrary data. The data from these theories can be fitted into a Flood model, a model in which the dinosaurs perished at different times within the first 150 days.

ACKNOWLEDGEMENTS

I appreciate and seek out discussion and input from other creationists. I thank Dr Andrew Snelling and Mr Peter Klevberg for reviewing an earlier draft of the manuscript. I benefitted from personal discussions with Dr Robert Brown, Mr Roy Holt and Mr John Woodmorappe, and from the comments of an anonymous reviewer.

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QUOTABLE QUOTE: Cosmological Interpretations

'One last point: It is true — as Jim Peebles mentions — that observers disagree. However, they do not disagree because the observations are ambiguous, but because they have contradicting theoretical preconceptions that lead to different interpretations. And that is what cosmology is based on: interpretations of interpretations of observations. We should not fall victim to cosmological hubris, but stay open for any surprise.'

Radecke, Hans-Dieter, 1997. **Science,** 275:603.

QUOTABLE QUOTE: On the Origin of Biological Complexity

'One of the great delights of scholarly pursuits such as biology is that we can aliform our own opinions!

Williams, George C, 1997. **Plan and Purpose in Nature,** Weidenfeld and Nicholson; quoted from **The Weekend Australian,** April 12, 1997, p. 7.