CGS Annual Conference Abstracts 2011

Seismic and Volcanic Data Supporting a Global Catastrophic Event with Implications for Catastrophic Plate Tectonics

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The USGS has compiled a database of 20th century earthquake data, consisting of earthquake magnitudes and year of occurrence. An analysis of the yearly earthquake data was conducted with a running average trend analysis (n=7) method using the number of yearly quakes of magnitude >=6.5, but less than 7. The analysis shows three sinusoidal trend cycles of frequency of occurrence, possessing a periodicity of 40-50 years; a pattern repeated with all quake data of magnitude >=6.5. Repeating the analysis with quakes of magnitude >=7 reveals 4 periodic cycles of 30-40 years with the running average peak amplitudes decreasing for the last three cycles. The trend analysis on data with magnitude >=8.2 (n=7 and n=9) have a pattern of 3 sinusoidal cycles with periodicity of ~40 years possessing declining peak amplitudes. Dating of the process(es) spawning the observed quake trend periodicity was done with a model consisting of a high Q oscillatory system with an exponentially damped sinusoid pattern. The magnitude 7+ data yielded an estimate of ~28,000 Years Before Present (YBP) and the magnitude 8.2+ data yielded a YBP estimate of ~38,000. These quake trend patterns suggest a transverse crustal/mantle pressure wave. The originating process for the quake trend patterns is consistent with a process involving a large upwelling of mantel material, but other processes may have been involved.

The above hypothesis was tested by trend analysis of the frequency of occurrence of large (VEI >=4) volcano’s using the data from the Smithsonian Global Volcanism Project’s “large volume Holocene eruption” databank (dating back to ~11,000 YBP). Contrary to expectation, frequencies of large volcanic eruptions have actually increased over the last two millennia, suggesting different geophysical process at work than that spawning the earthquake occurrence trend periodicity. A histogram analysis of the dataset (cell size =1,000 years, ~12 cells) reveals two complete cycles of rising/falling eruption frequencies possessing peaks ~8,000-9,000 YBP and ~ 4K YBP, followed by a substantial increase in large volcanic eruptions to the present. Repeating the analysis and eliminating VEI 4 events, showed two peaks occurring around 3,000 and 7,000 YBP respectively, with a sharp rise in frequency beginning at ~2,000 YBP. The analysis with VEI 6&7 data yielded 3 distinct frequency cycles with peaks around 500, 3,000 and 7,000 YBP; the peak amplitudes were curve fitted and extrapolated to zero at ~79,000 YBP. The earthquake and volcanic eruption data suggest a possible global catastrophe to have occurred around 30,000-78,000 years ago, which is consistent with the human genetic dating of the latest common ancestor, possibly arising from a population bottleneck.

The volcanic eruption patterns suggest geophysical processes at work which result in cyclical crustal/mantle boundary pressure build ups causing a repeated pattern of peak volcanic eruption frequencies. After each peak the large eruption frequencies decrease resulting from pressure relieved by the large volcanic eruption processes. These cycles of increasing eruption peak frequencies suggest that the geophysical mechanisms driving the eruption patterns are resulting from ever increasing crust/mantle pressure cycles, perhaps leading to a contemporary resurgence of VEI 8 volcanic eruptions or even leading to resurgence in the frequency of massive earthquakes (9+). The increasing numbers of earthquakes of magnitudes in the mid to upper 6’s may be correlated with the increasing frequency of large volcanic eruptions.

These patterns may shed light on catastrophic plate tectonic theory, where the stage is set by large core/mantle pressure relief from massive global volcanism leading to the continental plates settling down upon subducting ocean plates. The resulting huge increase in normal force/resistance would lead to a stalling of the normal plate subduction process. Settling of the continental plates upon the subducted portions of the ocean plates would lead to large tensile stresses within the plates. Some attempts to model the initiation of runaway plate subduction with a large asteroid strike don’t seem to show sufficient kinetic energy released to result in forces of sufficient magnitude to fracture an ocean plate, which would trigger runaway plate subduction. Large tensile stresses within the ocean plates resulting from stalled subduction could be of sufficient magnitude to provide sufficient potential energy when added to the kinetic energy of a large asteroid strike to fracture an ocean plate thus triggering runaway plate subduction.

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Citation: Journal of Creation Theology and Science Series C: Earth Sciences 1:2-8.
Pseudotachylyte and Superfaults: Evidence of Catastrophic Earth Movements

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Since its creation, the Earth has experienced two episodes of greatly increased geologic activity. The first occurrence was during Creation Week when God commanded the dry land to appear (Gen. 1:9), and the second event occurred during the upheaval associated with the Flood of Noah (Gen. 7-8). Snelling (2009) has suggested and described catastrophic movements within the Earth’s crust during Day 3 of Creation Week, when the continents were brought forth from beneath the ocean. Research by Austin et al. (1994) has suggested rapid plate motions, of up to meters per second, were necessary for their Catastrophic Plate Tectonics (CPT) model during the Flood event.

Superfaults were defined by Spray (1997) as unconstrained faults possessing very large displacement (> 100 m) and rapid movement (> 0.1 m/s) during a single-slip event. They have been associated with coherent rock slides, collapse of impact craters, and development of calderas (Spray 1997). Although extraterrestrial impacts and caldera formation may have occurred throughout history, these processes are more sporadic and are not tied directly to specific events as described in the Bible. In contrast, intact rock slides and large movements of the Earth’s crust seem to have occurred primarily at two junctures in Earth’s history, the Creation and the Flood.

The term pseudotachylyte (PST) was first used by Shand (1916) to describe dark, aphanitic veins and dike-like intrusions in the Vredefort impact structure, South Africa. Although PST was first associated with impact structures, it is commonly used as an indicator of high-velocity rock movement. Spray (1995; 1998) has further defined the term to include frictional melting during rapid fault movement. He spun two pieces of granite against each other at 1000 rpm for 2 seconds at a force of 0.5 kN, causing temperatures at the interface to reach at least 1000 oC, and creating PST (Spray 1995). Spray concluded that PST is a special type of cataclasite rock that contains some frictional melt. He found that PST is generated by seismogenic faulting in the brittle, upper 10-15 km of the crust, and can be used to infer past behavior of faults, confirming their rapid, catastrophic movement history (Spray 1995).

Two examples of superfaults are described in this paper: 1) in ancient crustal rocks in central Colorado where rapid shearing was part of continent development, and 2) in a subduction zone setting at Kodiak Island, Alaska where catastrophic plate movement rates are documented. Each location shows evidence, in outcrop and in thin section, of pseudotachylyte development within the fault or shear zone. At the Homestake Shear Zone in the Sawatch Range, Colorado, superfaulting has resulted in melting within gneisses and granites of Lower Proterozoic age. Along the southeastern edge of Kodiak Island, at Pasagshak Point, cataclasites and pseudotachylyte layers are developed in a subduction zone setting involving rocks of Jurassic through Eocene age. Both locations confirm that catastrophic superfaulting has occurred at critical times in Earth history. We interpret the melt at the Colorado location as evidence of rapid movement during the assembly of the North American continent during Creation Week. Similarly, we interpret the Kodiak Island melt as strong evidence of catastrophic plate movement during the Flood event.


Snelling, A.A. 2009. Earth’s Catastrophic Past: Geology, Creation & the Flood. Institute for Creation Research, Dallas, TX.


Overthrust Faulting: A Mechanical Paradox Explainable Only in a Flood Context

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The mechanical difficulty of moving large, coherent sheets of rock great distances down fairly flat slopes has never been fully explained in the geologic literature (Briegel 2001). Lithified sedimentary rock will not fold and behave plastically (Snelling 2009), yet we see the clear geometric results in overthrust belts around the globe. Creationists in the past have been right to criticize secular explanations for overthrusts (Whitcomb and Morris 1961). Today, however, creationists must accept the results of 100s of drill-hole penetrations and 1000s of kilometers of seismic reflection data, collected since the 1970s, proving the existence of overthrust faults. Authors who are critical of the geologic column should no longer use the denial of overthrusts as part of their argument. Instead, creationists should embrace these features as an opportunity to explain their occurrence within a Flood context.

The “rules” of overthrusting, established by the oil industry, suggest consistent movement directions away from uplifted regions. Overthrusts generally get younger in the direction of transport, often folding and further deforming the earlier-emplaced thrust sheets in the process. The apparent “uphill” movement of many overthrusts can be explained as a consequence of later folding by subsequent thrusts or by ramping uphill as the thrusting ceased. Overthrusts, generally, have a basal detachment from which all younger thrusts originate. Gravity seems to remain the only viable force to move overthrusts (Snelling, 2009). High fluid pressures, developing during dewatering reactions, have the ability to create overpressured zones and “float” large thrust sheets down slope (Clarey in press, Guth et al. 1982). The formation of supercritical carbon dioxide seems to be an additional method to move carbonate sediments rapidly (Beutner and Gerbi 2005).

More recent examples of overthrusting have been identified by seismic reflection data and well drilling in the Gulf of Mexico. The Perdido fold belt developed as non-lithified sediments slid across salt layers, under the force of gravity, creating folds.
similar to those observed in overthrust belts. Basal detachments developed within the salt layers due to rapid loading by sediments during late and post-Flood continental erosion.

This paper presents preliminary results of a sampling program across the Wyoming-Utah-Montana overthrust belt, funded by ICR. Numerous fault contacts were photographed and sampled for geochemical and thin-section analysis at locations across the overthrust system. In addition, the results of an earlier study of the South Fork fault system, and the associated Heart Mountain fault system, are used as an analogy for the overthrusting model.

All data suggest overthrust faults moved rapidly. Some fault breccia and/or fault gouge was identified along the surface contact of every overthrust. The breccia/gouge thicknesses varied from several meters to just a few millimeters. Numerous anastomosing normal faults, possibly relaxation structures, were observed along the leading edges of some of the thrusts, with some of these faults offsetting the thrust surface by a few meters.

Un lithified sediments, similar to those in the Perdido fold belt, are essential to the development of overthrust belts. These conditions must have occurred late in the Flood after most of the sediments were deposited, but while they were still un cemented. Rapid deposition during the Flood, with the associated dewatering, created overpressurized zones along impermeable boundaries. Uplift probably initiated sliding along these overpressurized horizons, causing thrusts to propagate. Once thrusting was initiated, tectonic loading likely caused subsequent thrusts to slide out from underneath, creating the “piggy-back” pattern of younger thrusts in the direction of transport.

Compaction of Sand in the Coconino Sandstone

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Large scale cross-bedding in sandstone formations is often interpreted as a series of preserved eolian dune foresets. If this is the case, the dip of the cross-beds should resemble the angle of the foresets of modern eolian dunes (32.0°-34.0°, Pye and Tsoar 2009). However, the cross-beds in the Permian Coconino sandstone in the southwestern United States dip at considerably smaller angles (20.2°, averaged from 214 sites). It has been proposed that compaction is responsible for the apparent reduction in dip angle in this and other cross-beded sandstones (Glennie 1972, Rittenhouse 1972). Thin section photos were taken from a variety of locations and individual grains were inspected for any destructive effects of compaction. The relative absence of fractured or shattered grains suggests that compaction alone may not be responsible for low cross-bed angles.

Potential cross-bed dip reduction was calculated with respect to initial dip (32.0°-34.0°) and hypothetical porosity at time of deposition. When initial void space is estimated at 25.0-35.0% total volume and is reduced to a generalized Coconino (minus cement) porosity of 15.0%, the smallest possible final dips fall between 22.1° and 29.4°, well above observed values.

Preliminary theoretical analyses on the limits of compaction indicate that compaction alone would not likely yield the low-angle cross-beds in the Coconino. When initial void space and relative quartz grain incompressibility are considered limiting factors, the requisite compaction appears infeasible. Additionally, minimal evidence of crushing or fracturing was found in microscopic analysis. In light of these development, other mechanisms for explaining low-angle cross-bedding should be evaluated.


Role of Aerosols in a Post-Flood Ice Age

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A post-flood Ice Age was proposed by Whitcomb and Morris in their book The Genesis Flood to explain glacial features in the Pleistocene. This proposal was fleshed out by Oard (1979) to include a warm post-flood ocean and volcanic dust. The warm oceans provide an enhanced source of water vapor, which can be precipitated over land masses, and the volcanic dust reduces the amount of solar radiation absorbed by the earth, thus leading to global cooling. It is anticipated that this combined effect along with other factors will lead to rapid accumulations of snowfall at higher latitudes, which will persist year-round and lead to a single ice age with multiple surges.

Spelman (1996) and Vardiman (1998) explored the impact of warm oceans on atmospheric circulation and precipitation using the National Center for Atmospheric Research Community Climate Model 1. The contrast between warm oceans and cool land masses leads to enhanced precipitation at higher latitudes. Similar results were obtained by the authors using the Goddard Institute of Space Studies (GISS) Model II (Hansen, 1983). These recent studies use an ice-free ocean with uniform sea surface temperatures of 30°C. This represents an average 26°C temperature increase over the whole ocean and will result in an increased ocean heat flux of 52 W/m².

Additional simulations were performed with the GISS Model II using reduced solar intensities. Results from simulations using solar intensities of 1025, 1100, 1150 and 1200 W/m² were extrapolated to determine a solar intensity reduction that offsets the warm ocean heating. Compared to the current solar intensity of 1361 W/m², a solar intensity of 1301 W/m² with 30°C oceans gives an average global surface temperature that is unchanged with respect to present day values. This 60 W/m² reduction in solar intensity is comparable to the 52 W/m² increase of flux based on sensitivity calculations.
Reduction in solar intensity is not the same as cooling due to volcanic eruptions. Although the ash cloud generated from an eruption can have a dramatic effect on the atmosphere, this effect only last for about a week. The long term impact of a volcanic eruption is an increase of stratospheric aerosols, primarily \( \text{SO}_2 \), that persist for several years. Measurements of surface solar radiation after the eruptions of El Chichon and Pinatubo (Robock, 2000) indicate that stratospheric aerosols reduce the direct solar radiation by 140 W/m², but enhance the indirect solar radiation by 100 W/m². For latitudes directly impacted by the plume of these volcanoes, a net solar reduction of 40 W/m² is comparable to that needed to offset the heat flux from a warm ocean.

To attain a global reduction of solar intensity necessary to potentially initiate an Ice Age, eruptions with magnitudes comparable to Pinatubo would be necessary at several different latitudes and occurring every several years. From Bluth et al. (1992) Pinatubo injected 20 Mt of \( \text{SO}_2 \) into the atmosphere. An initial estimate of 40-60 Mt being injected each year seems reasonable to offset the effect of warm oceans. These values will be used in future studies to determine the actual aerosol content needed to offset warm oceans. If eruptions of these magnitudes have occurred subsequent to the flood, evidence of such eruptions should be present in the geological record.


### Baraminological Analysis of the Caseidae (Synapsida: Pelycosaurs)

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Previous creationist research has indicated that the level of the created kind, or holobaramin, is at or near the family level in living organisms (Wood, 2006). However, little research has been done to expand this concept to fossil organisms. In this study, a family of pelycosaur reptiles, Caseidae, was analyzed through the use of statistical baraminology. Pelycosaurs is a grouping of basal synapsids or “mammal-like reptiles” considered paraphyletic by conventional researchers. Since pelycosaurs are thought to be the distant ancestors to mammals by the mainstream scientific community, it is imperative that creationists analyze their relationships through baraminology. Caseids all share a number of characteristics with each other, and superficially appear to be discontinuous with other organisms. Thus, the author hypothesized that continuity should exist within the Caseidae, and that there should be discontinuity between caseid taxa and non-caseid taxa. A cladistic study from “Cranial Anatomy of *Ennatosaurus tecton* (Synapsida: Caseidae) from the Middle Permian of Russia and the Evolutionary Relationships of the Caseidae” by Maddin, Sidor, and Reisz (2008) was reanalyzed through baraminomic distance correlation (BDC). The characters in the Maddin, Sidor, and Reisz 2008 paper included 73 cranial and dental characters, as well as 33 postcranial characters for a total of 106 characters. Twelve taxa were used by those authors including a taxon larger than the genus level (Reptilia). The character relevance cutoff for the BDC was 0.85 which allowed for 66 characters to be used of which the large majority (61) were cranial and dental. Nine of the twelve taxa were used with a taxic relevance cutoff of 0.60. This excluded *Oromycter* and *Angelosaurus*. The other excluded taxon was Reptilia since it was far above the genus level. Of the taxa used for this analysis, four were caseid taxa, three were pelycosaur outgroup taxa, and two were non-pelycosaur outgroup taxa. The four caseid taxa (*Cotylorhynchus, Ennatosaurus, Casea rutena*, and *Casea broilii*) all show positive BDC. There is negative BDC between the pelycosaur outgroup taxa (*Varanos and Mycterosaurus*) on the one hand and the four caseids, *Limnoscelis*, *Diadectes*, and *Eothyris* on the other. The positive BDC suggests continuity between the four caseid taxa and that Caseidae is a monobaramin.

The negative BDC implies discontinuity, suggesting the presence of a holobaramin of *Cotylorhynchus, Ennatosaurus, Casea rutena, Casea broilii, Eothyris, Limnoscelis*, and *Diadectes* to the exclusion of *Varanos* and *Mycterosaurus*. More research should be done in order to expand our understanding of the relationships between the pelycosaur, therapsid, and fossil mammal taxa.


### The Geomorphology of the Uinta Mountains and Its Implications

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Geomorphology is a “gold mine” for Flood evidence (Oard, 2008). The runoff of the Floodwater, first as wide currents and lastly as narrow currents, are readily observed on the surface of the continents. Most of these surface features, called landforms, are difficult if not impossible for uniformitarian geologists to explain. The Uinta Mountains, one of three major east-west ranges in the Western Hemisphere, is no exception to providing evidence for Flood runoff. The Uinta Mountains are one of many fault-blocked mountain ranges adjacent to subsided valleys in the Rocky Mountains.

As the Uinta Mountains were uplifted and massive erosion occurred. A high level summit flat, called the Wild Mountain upland surface, left erosional remnants over a considerable area.
A little lower a large, coarse gravel capped pediment formed along the north and south sides of the uplift. This pediment, called the Gilbert Peak erosion surface, bevels rocks of all ages within the uniformitarian geological column (Bradley, 1936; Hansen, 1986). The "gravel" up to large boulder size is called the Bishop Conglomerate and is commonly composed of red Uinta Group Quartzite from the heart of the mountains. Pediments are not being formed today, but are being destroyed. They are readily explained by fast Floodwater flowing parallel to the mountain range (Oard, 2004). After forming, the Gilbert Peak erosional surface was greatly dissected by subsequent erosion, which must have occurred late in the Flood because of the huge amount of rock eroded. On the north side of the Uinta Mountains, remnants of the Gilbert Peak erosion surface extend away from the mountains for about 50 miles.

Another piece of evidence for the Flood is the presence of water gaps through the Uinta Mountains and smaller uplifts on the east and southeast side. The Green River forms a major water gap through Ladore Canyon, a narrow canyon half a mile deep through the eastern Uinta Mountains. There are other water gaps associated with the Green River. The Yampa River is just as anomalous in passing through barriers and not going around them. Before the Yampa River joins the Green river, it flows into the heart of the eastern Uinta Mountains. Water gaps easily formed during the Flood during channelized erosion but are nearly impossible to explain by uniformitarianism.

One implication of the study of the geomorphology of the Uinta Mountains is that the Flood/post-Flood boundary appears to lie in the late Cenozoic in this area. This is because uniformitarian geologists date the pediment and water gaps in the Cenozoic. The Bishop Conglomerate is dated as Oligocene, for instance. The extensive erosion of the Gilbert Peak erosion surface would come after the Oligocene.

A second implication is that large erosional remnants of the Gilbert Peak erosion surface capped with Bishop Conglomerate north of the Uinta Mountains bevel sedimentary rocks of the Green River and Bridger Formations (Hansen, 1986). Such a relationship implies that these are Flood formations and not post-Flood formations, reinforcing previous conclusions based on the incredible amount of erosion of the southern outcrop of the Green River Formation (Oard and Klevberg, 2008).

Biogeography and Biostratigraphy: Coupled Constraints on the Placement of the Post-Flood Boundary

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The present distribution of living organisms is the consequence of numerous Flood and post-Flood related events. For those nephesh creatures taken aboard Noah’s ark, the biogeography of the modern species is primarily reflective of the migration and/or transport of original ark-borne progenitor animals from the mountains of Ararat combined with intrabaraminic diversification (e.g. speciation). Whether baramins were small (such as genera) or large (families or higher taxonomic categories), speciation events may be recorded in post-Flood sediments, leaving a biostratigraphic record of intrabaraminic diversification leading to the present.

While a number of criteria have been offered for determining the location of the Flood/post-Flood boundary (e.g. Whitcomb and Morris 1961, Whitmore and Garner 2008, Snelling 2009, Oard 2010), there remains as yet no consensus. Opinion is primarily split between a boundary at or near the Cretaceous/Paleogene (=Tertiary) or the Pliocene/Pleistocene. I submit that a robust biostratigraphic analysis will aide in determining the location of the Flood/post-Flood boundary. The reasons are as follows. Given that the pre-Flood distribution of continents was markedly different than the modern distribution, pre-Flood ecosystems would likewise be different from modern ones. As a result, it is unlikely that the post-Flood dissemination of animals would result in a return to their pre-Flood geographic locales. In other words, it is unlikely that species of baramins taken aboard the ark would display a proclivity to migrate to the graveyards of their deceased, pre-Flood baraminic kin.

Here I report a preliminary biostratigraphic analysis of twenty-eight North American terrestrial mammalian families, chosen from the following Orders: Artiodactyla, Carnivora, Edentata/Xenarthra, Insectivora, Lagomorpha, Marsupialia, Perissodactyla, and Proboscidea. All families contain members that are either extant or last appear in Pliocene or Pleistocene deposits.

Methods

Mammalian families were analyzed using the Paleobiology Database (www.pbdb.org). First, the family name (e.g. Canidae) was entered into the “Count taxa” tool to determine the North American fossil genera within each family. The genera were then imported into the “Analyze taxonomic ranges” tool. Selecting “no confidence intervals” retrieves only the raw occurrence data, with no estimates on biostratigraphic ranges above or below first and last appearances. I evaluated the differences in reporting which result from selecting the two time scales: stages and North American Land Mammal Ages (NALMAs). The NALMAs provide more accurate documentation of both the number of genera included and the completeness of their respective fossil record, thus providing more accurate biostratigraphic ranges than stages when compared against the published records of Janis et al. (1998, 2008). Also, using the NALMAs removed non-North American taxa consistently (and curiously) included in all stage-based searches of North American mammals.
Results and Analysis

Twenty-seven of the twenty-eight mammal families studied include at least one genus which crosses the Flood/post-Flood boundary when placed at the Pliocene-Pleistocene, and many families display multiple boundary-crossing genera. The lone exception is the Rhinocerotidae, whose last members in North America suffer extinction during the Pliocene (see also Janis et al. 1998). Of the 303 genera surveyed, 70 (23%) cross the Pliocene/Pleistocene boundary.

This would require that post-Flood baramin members (taken here as species within the same genus) from nearly all mammalian families studied here migrated across continents to coincidentally inhabit the same geographic locations of their pre-Flood (or transported, Flood-buried) baraminic kin. Rather than pointing to a Pliocene-Pleistocene location for the Flood/post-Flood boundary, these data are more naturally interpreted as representing time-sequential recolonization of the post-Flood world by diversifying terrestrial mammal baramins given a Cretaceous-Paleogene location for the Flood/post-Flood boundary.


Snelling, A. 2009. Earth’s Catastrophic Past: Geology, Creation & the Flood. Institute for Creation Research, Dallas, TX.


Fractures in Central Wyoming: Indicators of a Single Orogenic Event and Its Subsequent Collapse

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Independent Scholar

Presuppositions from ancient Hebrew poetry (Psalms 104:8; Job 14:18) indicate the possibility of two-stage deformation along the leading edge of runway plates during catastrophic tectonic movement associated with a global flood. A compressional stage, caused by collision and resulting in orogenesis, would be followed, as compressional stress is released, by an extensional stage caused by return towards isostatic equilibrium and resulting in orogenic collapse. Additional stages of deformation would not be consistent with a single catastrophic event, such as the one modeled by Baumgardner (1994).

Fractures, an in-elastic strain within the rock record, are used to test these presuppositions. Determining the type of fracture and its orientation constrains the orientation of the causal stresses, while either the relative age of the rock, or the cross-cutting/abutting relationships between the fractures constrains the relative timing of different stress orientations. Understanding causal stresses and their timing allows the construction of sequential geomechanical models.

16,676 fractures from 84 locations throughout the Wind River Basin in central Wyoming from Cambrian to Eocene strata were analyzed using eigenvectors (Thompson & Erslev, in review). Calculated least-compressive stress poles of 842 fractures are consistent with ENE directed horizontal compression during Laramide orogenesis, which began in the late Cretaceous and was associated with collisional plate interactions. These fractures include mean NW-SE striking thrust faults, ENE-WSW striking left-slip faults, NE-SW striking right-slip faults, and ENE-WSW and NNW-SSE striking systematic joints; all found in Cambrian to early Eocene strata.

15,659 fractures, consisting of NNW-SSE to ENE-WSW striking systematic joints and normal faults, were found mainly in Paleocene to late Eocene strata. These include fractures from post-Laramide strata and 4,823 induced fractures caused by drilling operations. Calculated least-compressive stress axes are inconsistent with Laramide stresses and show highly localized strike variations that likely parallel strike irregularity in major thrust faults underlying the basin-bounding structures. This parallelism indicates that these fractures may be caused by stresses consistent with backsliding on these thrust faults and post-orogenic extension, resulting in collapse of the basin-bounding structures, especially along their margins in proximity to the thrust faults.

Fracture data from the Wind River Basin supports only two-stages of deformation. Because of the presence of structures oblique to Laramide compression, Laramide thrust fault strikes vary from N-S to E-W; and also because of the localized variation in the post-Laramide fractures, almost all orientations of the compass may be grouped into two stages of deformation; thus masking hypothesized prior stages.

Similar fracture studies from across the Rocky Mountain Foreland, summarized by Erslev & Koenig (2009), show fracture and fold orientations that generally strike NNW-SSE to NW-SE. There is little difference in orientations between fractures and folds found strictly in Precambrian, pre-Laramide, or Laramide rocks; which makes hypothesized pre-Laramide orogenic events irresolvable at a regional scale. The implication being that Ancestral Rocky Mountain and Laramide deformation may have resulted from the same causal stresses, indicating a single, long-lived orogenic event. Even crystalline dikes cutting Precambrian granite strike NE-SW to ENE-WSW across Wyoming, consistent with Laramide stresses.

From the data presented, only two stages of deformation may be resolvable as having resulted from distinct causal stresses in the Rocky Mountain Foreland. The first, a compressional stage resulting in orogenesis and lasting until the mid-Eocene, and the second, a post-orogenic collapse stage, which began shortly afterwards and continues to present. The data and results presented are consistent with catastrophic plate tectonic models and presuppositions from ancient Hebrew poetry.


Erslev, E.A. and N.V. Koenig. 2009. 3D kinematics of Laramide, basement-


New Finds in the Coconino Sandstone, Arizona

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The Coconino Sandstone of central and northern Arizona is best known for its large-scale cross-stratification and most workers therefore interpret it as an eolian sandstone. However, our recent field work has found some previously unrecognized bedding styles and features that suggest this sandstone was probably deposited in an aqueous setting. Furthermore, field observations demonstrate the sandstone was water-saturated during seismic events that must have occurred before lithification.

One-meter-thick and up to forty-meter-long massive beds occur in the Grand Canyon area at the base of parts of the formation. We have found these layers along Grandview Trail, Hance Trail, South Fork of Rock Canyon and along the Colorado River near the Navajo Bridge. These beds sometimes contain stratified clasts of Coconino Sandstone and are intimately associated with sand injectites below them (Whitmore and Strom, 2010). Higher in the formation, several flat-bedded horizons (which are several meters thick, laminated and contain carbonate cement) have been found along Hance and Hermit Trails. Another flat-bedded zone was found along the Colorado River under Navajo Bridge. These zones may correlate with flat-bedded horizons found over 100 km to the south in the Sedona and Holbrook areas, some of which also contain carbonate cement. The petrography is still not complete on these horizons, but outcrop observations seem to indicate the flat-bedded zones do not differ much in grain size and sorting from the cross-bedded portions of the sandstone; with the exception of some medium to coarse sand in the flat-bedded portion of the Navajo Bridge section. We have previously reported several thin, but pure dolomite beds near the base of the formation in the northwestern part of the Grand Canyon (Cheung et al., 2009). In Sedona, one- to four-meter-thick sequences of contorted and convolute bedding have been found above the flat-bedded horizons. The convolute layers were traced for over 100 m in one location, and may be continuous for over several kilometers.

The massive beds and convolute beds are indicative of seismic activity in water-saturated and unlithified sand. These kinds of features occur during intense seismic events and are caused by partial or complete liquefaction of water-saturated sand. In a conventional model, the seismic events causing these features must have occurred well after the deposition of the sandstone, during Laramide events (see Whitmore and Strom, 2010); but it is difficult to understand how the sand could have remain unlithified since Permian times.

The flat beds and the dolomite beds are indicative of extensive aqueous deposition for at least parts of the formation. It is possible for flat-bedded horizons to occur in desert settings, but when they occur they are often found between dunes or in interdunal ponds. Interdunal sediments are notoriously poorly sorted, quite localized, characterized by discontinuous laminae and sometimes contain mud-chip breccias and lag deposits (personal observations; Pye and Tsoar 2009). We cannot envisage any eolian setting that can explain the extensive thick flat-bedded deposits that we are finding (kilometers long in the Sedona area). We believe it is also untenable for 3-5-cm-thick, very pure dolomite beds to be deposited in interdunal ponds. The Coconino is usually considered to be an entirely wind-blown deposit; however, these observations strongly suggest otherwise.

