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Sandy Gravity Currents as the Primary Sediment Transport Mechanism during the Global Flood

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What was the "conveyor belt" that moved millions of cubic kilometers of ocean sediment through distances of many hundreds of kilometers over continental platforms and margins in a rapid manner during the Global Flood? We studied laboratory-scale models of sedimentary process, applied computational fluid dynamics to simulate sediment gravity currents, and documented some real-world examples within stratified sedimentary rocks. A device we call a "zag tube" illustrates both uniformitarian and catastrophist models of sediment transport. *Vertical* sediment fall within the zag tube produces a low-density suspension and "hindered settling," a demonstrably slow transport process. It simulates sedimentation from dilute tractive currents (e.g., river deltas and submarine canyon turbidity currents) where water current turbulence lofts and moves sediment. *Inclined* sediment fall within the zag tube produces a high-density suspension by the "boycott effect," a much faster and concentrated movement of sediment. Inclined settling within the tube simulates submarine, sandy gravity currents (sometimes called "sandy debris flows") where liquefied sediment in laminar flow moves the entrained water. Slurry-flow experiments ("Fish Tank" at St. Anthony Falls Laboratory, University of Minnesota) made sandy gravity flows that were 50% by volume fluid and a density twice that of the tank's water. Flows reached velocities sufficient to hydroplane, retained a cohesive and liquefied plug with laminar shear at boundaries, and, during unsteady declining flow, quickly deposited massive or graded sand beds. These sandy debris flows displayed a shear-thinning rheology (the "ketchup effect"). Computational fluid dynamics (CFD) simulated a 4-meter-thick sandy gravity current on a nearly level surface. The computer-simulated current hydroplaned at a velocity of more than 5 meters per second. Dynamic pressure at the head of the flow was balanced by the added static pressure beneath the flow. Internal friction was significantly reduced by silt particles killing the intergranular porosity, thereby inducing liquefied flow. Mobility was further enhanced by shear-thinning rheology, laminar flow, and a wing-shaped head that generated lift. There appears to be a thickness-velocity-concentration window of stability for slurry flow. This window theory suggests that a submarine gravity current can be torn apart abruptly at the onset of turbulence producing "flow transformation." Turbulence within the flow abruptly dilutes the current, nullifies the wing shape, destroys the liquefied particle-support mechanism, and defeats the hydroplane. After flow transformation, sediment deposition with the familiar Newtonian rheology follows quickly. Many Holocene gigantic seafloor debris flows (e.g., Storegga Slide, western Norway coast, volume 2,500 cubic kilometers) have horizontal runout distances of many hundreds of kilometers over the deep ocean floor. Submarine debris flows have been established as one of the most important agents of mass wasting at the continental margins of modern oceans. The "zag tube options" for sedimentation of the stratigraphic record are powerfully illustrated by the mudstones and sandstones of Fountain Formation (Pennsylvanian, Colorado Rockies). The MacColl Ridge Formation (Late Cretaceous, Wrangellia Terrane, southern Alaska) displays extraordinary matrix-supported conglomerates deposited from debris flows that moved northward. Sandstone strata of MacColl Ridge Formation increase in abundance northward and display upper-plane-bed bedforms indicating flow transformation. The 2-meter-thick "Whitmore Floatstone Bed" (Redwall Limestone, Mississippian, Grand Canyon region, Arizona, Utah and Nevada) has matrix-supported clasts with rapidly buried nautiloids diagnostic of a current moving 7 meters per second westward. Floatstone volume is about 25 cubic kilometers with the bed thickening significantly westward into Nevada where upper-plane-bed bedforms indicate flow transformation and slower current velocity. Rhythmic, fine-textured carbonate muds that lay abruptly on top of the floatstone are diagnostic of bidirectional flow indicating that the ocean recoiled in oscillation after the giant mass of slurry passed. The Pine Creek Limestone Member (Pennsylvanian, Glenshaw Formation, northern Appalachians), although less than one meter thick, is extremely persistent in West Virginia, Pennsylvania and Ohio. It displays matrix support of imbricate marine fossil fragments that is diagnostic of sandy carbonate debris flow. Therefore, a strong case can be made for slurry-flow transport from (1) laboratory-scale models of gravity currents, (2) computer models employing computational fluid dynamics, and (3) stratified field outcrops displaying criteria diagnostic of debris flow. Sandy gravity currents appear to have been the primary sediment transport agent ("conveyor belt") that accompanied the Global Flood.

Density Overburden in Relation to Salt Tectonics

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Large formations of rock salt are found within basins of hundreds of thousands of square kilometres wide. Rock salt is

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here defined as collective noun for all salts that are found inside this so-called evaporites. Thus including halite, anhydrite, carbonate, potash, etc. After deposition the salt layers have been covered with sediments. Chiefly due to density contrasts between salt and sediments salt domes have been formed, kilometres tall, synsedimentary. This process is called salt tectonics.

Salt flow is reproduced on laboratory scale at a stress difference of about 300 bar (Robertson, 1958). The pressure gradient applied on the salt sample was clearly >>100 bar/m. Whereas in situ rock salt must have crept horizontally tens of kilometres (Gevantman, 1981). If, by example, the density-contrast caused a pressure difference of 100 bar and was released over a distance of 3 km, that amounts to a pressure gradient of just 0.033 bar/m. A difference between test and reality of three orders of magnitude which makes the test invalid to confirm the model! Table 1 zooms in upon the validity of the density-contrast. It is surprising that each author was free to pick a density-contrast that suited the applied model.

Table 1. Density-contrasts. Overburden is the sedimentary rock top-salt. Authors do not refer to measurements.

Salt Tectonics Model	**Rock Salt (kg/m^3)**	**Overburden (kg/m^3)**	**Contrast (kg/m^3)**
Schultz-Ela, 1993	2200	2400	200
Keken, 1993	2160	2300	140
Poliakov, 1996	2200	2500	300
Gemmer, 2005	2200	2300	100
Fuchs, 2011	2264	2600	336

It is therefore important to verify density measurements taken from core samples. Core samples from the Dutch subsurface have been sampled by mining companies:

- **2042** density measurements out of the overburden show that density increases with depth from 1300 kg/m^3 (ground level) to 2100 kg/m^3 (500 m) to 2400 kg/m^3 (3000 m), which is much less dense than assumed in table 1.
- **354** density measurements from cores out of rock salt show an average density of 2702 kg/m^3. But in this measurements the less dense halite is missing. Tysma (1993) defines rock salt on 2300–2400 kg/m^3 which seems correct. This is in sharp contrast to the densities that have been used by the models as listed in table 1.

These actual data show a density-cross-over-depth at about 2500 m. As some salt domes are even risen above ground level, it can be concluded that there is no valid model to explain salt tectonics.

Density contrasts can only facilitate salt tectonics if the salt was magma with a much lower density. Salt formations formed as fluids, and the sediments moved synchronically fluid-like as well, reminiscent of the mechanism in a lava lamp. Therefore salt pillars must have been formed synsedimentary when the sediments were unconsolidated during the Flood.

Fuchs, L., H. Schmeling, and H.Koyi. 2011. Numerical models of salt diapir formation by down-building: the role of sedimentation rate, viscosity contrast, initial amplitude and wavelength. *Geophysical Journal Int*. 186:390-400.

Gemmer, L., C. Beaumont, and S.J. Ings. 2005. Dynamic modelling of passive margin salt tectonics: effects of water loading, sediment properties and sedimentation patterns. *Basin Research* 17. 383–402.

Gevantman, L. H. et al. 1981. Physical Properties Data for Rock Salt. *National Bureau of Standards Monograph* 167:1-282.

Keken, P.E. van, C.J. Spiers, A.P. van den Berg, and E.J. Muyzert. 1993. The effective viscosity of rocksalt: implementation of steady-state creep laws in numerical models of salt diapirism. *Tectonophysics* 255:457-476.

Poliakov, A. N. B., Y, Y. Podladchikov, E. C. Dawson, and C. J. Talbot. 1996. Salt diapirism with simultaneous brittle faulting and viscous flow. *Geological Society Special Publications* 100:291-302.

Robertson, E.C., R.A. Robie, and K.G. Books. August 1958. Physical Properties of Salt, Anhydrite, and Gypsum--Preliminary Report. *Trace Elements Memorandum Report* 1048:1-38.

Schultz-Ela, D.D., M.P.A. Jackson, and B.C. Vendeville. 1993. Mechanics of active salt diapirism. *Tectonophysics* 228:275-312.

Tysma, S., et al. 1993. *Poly Technisch Zakboekje*, 45th ed. Koninklijke PBNA, Zwijndrecht, Netherlands.

On the Aquatic Habits of Sauropods – An Antiquated Theory in Need of Revival?

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When sauropods were first discovered, they were thought to have been confined strictly to life in the water in part due to their immense size. This image of sauropods was thrown out in the 1950's when it was determined that the lungs would have been placed under massive amounts of pressure, rendering breathing nearly impossible (Kermack, 1951). These experiments were later dismissed due to a realization that pneumatic features were not factored in due to a lack of understanding of how they could have related to aquatic behavior.

Sauropods possessed pneumatic features in all their presacral vertebrae, which were identified as weight-saving structures upon their discovery. These features kept the strength and integrity of the bone while dramatically reducing its weight. The postcranial skeletal pneumaticity is indicative of a physical relationship between the vertebral column and the pulmonary system. A similar phenomenon is exhibited in modern birds. In particular, neosauropods show signs of air sacs in the lower back and hip regions, possessing abdominal air sacs like modern birds, though this is still unclear (Wedel, 2003). Other sauropods, by contrast, only possess such pneumatic features in the cervical vertebrae.

The potential effects of a highly pneumatized skeleton on a sauropod's buoyancy were not considered until the 1970's. Henderson (2004) concluded in his study on sauropod buoyancy that it would be impossible for sauropods to walk along the bottom of a body of water that was deeper than chest-height, as their high calculated buoyancy would cause the animal to capsize, albeit while keeping their head above the water, thus allowing it to survive a flood for a time. Both Henderson (2004) and Kermack (1951) came to conclusions that are perfectly reasonable. However, perhaps we should not be so quick to rule out the idea of sauropods being semi-aquatic. If this hypothesis were to be investigated further, there are several criteria scientists might take into consideration. For instance, it is possible sauropods possessed reinforced peripheral airways that allowed their lungs to collapse when under higher pressures, similar to those in deep-diving whales and seals (this is not to suggest sauropods were deep-marine animals) – something that is difficult to preserve in the fossil record. Additionally, if sauropods had a higher muscle mass than generally assumed, it would help to negatively affect the animals' buoyancy calculated in Henderson's (2004) experiments, helping to weight the animal down and prevent capsizing. Legs composed of more dense bone than the rest of the skeleton (something I could not find noted one way or the other in the large amount of literature I reviewed) could act as ballasts, further helping prevent a sauropod from capsizing. If the latter hypothesis is correct, it is something that could be observed in fossils. Keep in mind much of this evidence is purely theoretical, with no way of physically observing phenomena in the fossil record. Overall, the evidence pointing towards sauropods being exclusively terrestrial animals is based on assumptions that perhaps should be reconsidered in light of suggested adaptations sauropods may have possessed, some being invisible in the fossil record.

From a creationist standpoint, the fact that sauropods had the potential for being semiaquatic animals could help explain their distribution in the fossil record (proliferous in the late Jurassic, and thinning out in total number of species but remaining, and in some respects, prosperous and widespread through the later Cretaceous Flood sediments), as they may have been able to keep afloat longer than other animals, (assuming they had the aforementioned adaptations).

Henderson, D.M. 2004. Tipsy punters; sauropod dinosaur pneumaticity, buoyancy and aquatic habits. *Proceedings of the Royal Society of London, Biological Sciences* 271:S180-S183.

Kermack, K.A. 1951. A note on the habits of sauropods. *Annals and Magazine of Natural History* 4:830–832.

Wedel, M. J. 2003. Vertebral pneumaticity, air sacs, and the physiology of sauropod dinosaurs. *Paleobiology* 29(2):243-255.

Lance Formation Stratigraphy (Maastrichtian, Upper Cretaceous): Research Status Report

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Numerous factors have hampered resolution of the Lance Formation's internal stratigraphy, including grass cover and low topographic relief (<500') in the region of the formation's exposures, as well as much of the formation's great thickness (>2500'), low dip (~3°), discontinuous lithification, and common inter-fingering of lithologies. In a local exposure of the Lance, Weeks and Chadwick (2011) reported a 6' seismite. The seismic wave required to generate such a seismite ought to create seismic disturbance across the Lance's entire depositional basin. Hoping to trace the seismite across the Lance to resolve the formation's internal stratigraphy, the author examined the Weeks and Chadwick locality (Glen Hanson Ranch) in northernmost Niobrara County in June, 2013 and the type area of the Lance Formation in central Niobrara County (8-30 miles to the south) in June, 2014.

From the Glen Hanson Ranch, the seismite was traced several miles into southern Weston County, doubling its reported areal extent. Two additional beds were confirmed as local stratigraphic markers – one above the seismite (a boulder breccia) and one below the seismite (an *Edmontosaurus* bone bed). At the Lance Formation's type area, the uppermost 150' of the formation was examined in one district (Cow and Lightning Creek valleys near their confluences with Lance Creek) and the lowermost 200'-400' was examined in two other districts along Lance Creek (one where the creek first crosses into the exposures of the formation and the other near the creek's confluence with the Cheyenne River). Three seismites (3-6', 12', 3-12') were located in the lowermost 200' of the formation at two locations 13 miles apart. Two more seismites (3-6', 6') were located 150'-170' higher, two additional seismites (6', 30') were located in the top 150' of the formation, and another seismite (6') was located near the base of the overlying Fort Union Formation.

Although only about 10% of the Lance Formation thickness has been examined thus far, the following preliminary observations are possible:

1. Published geologic maps err in the placement of the upper boundary of the Lance Formation by as much as a mile in places. Published estimates of the stratigraphic position of fossils in the formation are also in need of substantial revision.
2. Assuming constant seismite frequency, we expect >60 seismites in the Lance – perhaps 10-15% of the formation's total thickness. Though common, distinctive, prominent, easy to follow, and located in an oft-frequented locality, type Lance seismites are previously unreported. This suggests seismites may be many times more common in the entire stratrigraphic column than currently believed (at frequencies consistent with Flood geology).
3. Lance seismites evidence extraordinarily catastrophism. A preliminary literature survey suggests that earthquake power increases exponentially with seismite thickness – with a 3' seismite considered too massive to be generated by present-day earth-based process. At least one Lance seismite is an order of magnitude *thicker* than that. At the same time, the frequency of Lance seismites argues against an extraterrestrial bombardment. Lack of obvious diminution of thickness at sites thirteen miles apart confirms the enormous power of the seismite-generating waves. Subduction of the Farallon Plate at the rates suggested by catastrophic plate tectonic theory may be the only viable cause for these seismic disturbances.
4. The correlation of three seismites – each in its own sandstone unit – between localities thirteen miles apart, combined with light-colored sandstone beds being often visually traceable for up to two uninterrupted miles, suggest that at least some of the Lance beds are sheet sands (and thus marine deposits). Rapid subaqueous deposition of the Lance is implied by the convoluted bedding of the seismites (which require unlithified and water-saturated sediments at the time of formation). At the Glen Hanson Ranch, both the boulder breccia and the *Edmontosaurus* bonebed (a 1.5' zone of normally-graded bones – including vertically oriented bones – in the middle of a 6' massive mudstone) are interpreted as subaqueous debris flows – the latter in fairly deep water. Though traditionally interpreted as a slowly-deposited, terrestrial, braided stream deposit, the Lance Formation is better explained as a catastrophically-deposited, subaqueous, marine deposit.

Weeks, S.R. and A.V. Chadwick. 2011. A Prominent Seismite in the Upper Cretaceous Lance Formation in Northeastern Wyoming as a Stratigraphic Marker. *Geological Society of America Abstracts with Programs* 43(5):280.