pile, the large grains are more likely to be found near the base, while the small grains are more likely near the top.[13] Furthermore, when a granular mixture is poured between two vertical plates, the mixture spontaneously stratifies into alternating layers of small and large grains whenever the large grains have a larger angle of repose than the small grains. Application — the stratification is related to the occurrence of avalanches.

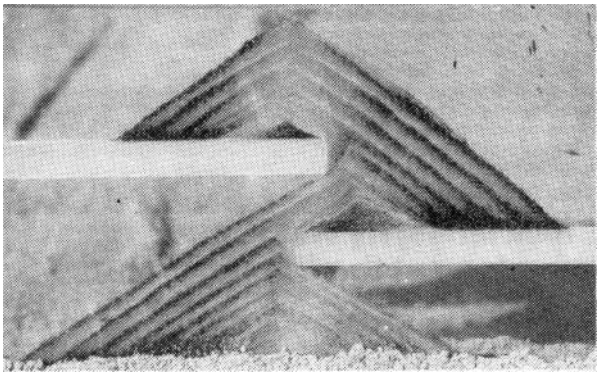

Figure 3. *Spontaneous strata. Alternating layers formed by a mixture of two types of grains, poured into a narrow container.*
(Photo: H. A. Makse)

Fineberg agrees.[14] Both the stratification and segregation of a mixture of two types of grains can be observed to occur spontaneously as the mixture is poured into a narrow box, the mixture flowing as the slope of the 'sandpile' formed steepens. When the angle of repose of the larger grains is greater than that of the smaller grains, the flow causes spontaneous stratification of the medium to occur, and alternating layers composed of large and small particles are formed, with the smaller and 'smoother' (lower angle of repose) grains found below the larger and 'rougher' grains (see Figure 3. Even within the layers, size segregation of the grains occurs, with the smaller grains tending to be nearer the top of the pile.

We are naturally heartened by this 'high-profile' confirmation of Berthault's experimental results, but readers of **Nature** could have read all about it more than a decade ago in the **Creation Ex Nihilo Technical Journal.** However, what this also confirms is that creation scientists do undertake original research, in this case, research on sedimentation that is applicable to the catastrophic processes of deposition during the Flood, contrary to the establishment's uniformitarian (slow-and-gradual) interpretation of the formation of such sedimentary strata. And furthermore, creation scientists not only do original research applicable to Flood geology (even if **Nature** doesn't recognise it), but the type of research they do is valid and good enough to be published in peer-reviewed secular scientific journals.

REFERENCES

1. Berthault, G., 1988. Experiments on lamination of sediments. **EN Tech. J., 3:** 25-29.
2. Berthault, G., 1986. Experiments on lamination of sediments, resulting from a periodic graded-bedding subsequent to deposition — a contribution to the explanation of lamination of various sediments and sedimentary rocks. **Compte Rendus Académie des Sciences, Paris, 303** (Serie II, no. 17):1569-1574.
3. Berthault, G., 1990. Sedimentation of a heterogranular mixture: experimental lamination in still and running water. **EN Tech. J.,** 4:95-102.
4. Berthault, G., 1988. Sedimentation of a heterogranular mixture: experimental lamination in still and running water. **Compte Rendus Academic des Sciences, Paris, 306** (Serie II):717-724.
5. Julien, P. Y, Lan, Y. Q. and Berthault, G., 1994. Experiments in stratification of heterogeneous sand mixtures. **CEN** Tech.J.,8(l):37-50.
6. Julien, P. Y, Lan, Y Q. and Berthault, G., 1993. Experiments on stratification of heterogeneous sand mixtures. **Bulletin of the Geological Society of France, 164(5):** 649-660.
7. Austin, S. A., 1986. Mount St Helens and catastrophism. *In:* **Proceedings of the First International Conference on Creationism,** R. E. Walsh, C. L. Brooks and R. S. Crowell (eds), Creation Science Fellowship, Pittsburgh, Pennsylvania, Vol. l,pp. 3-9.
8. Austin, S. A., 1994. Interpreting strata of Grand Canyon. *In:* **Grand Canyon: Monument to Catastrophe,** S. A. Austin (ed.), Institute for Creation Research, Santee, California, Chapter 3, pp. 21-56.
9. Wilders, P., 1992. **Evolution: Fact or Belief?** Video, Creation Science Foundation Ltd, Australia.
10. Berthault, G., 1995. **Drama in the Rocks.** Video, Creation Science Foundation Ltd, Australia.
11. Makse, H. A., Havlin, S., King, P. R. and Stanley, H. E., 1997. Spontaneous stratification in granular mixtures. **Nature,** 386:379-382.
12. Fineberg, J., 1997. From Cinderella's dilemma to rock slides. **Nature, 386:** 323-324.
13. Makse *et al.*, Ref. 11, p. 379.
14. Fineberg, Ref. 12, p. 323.

A. A. Snelling

Are pre-Pleistocene Rhythmites Caused by the Milankovitch Mechanism?

Cyclic sedimentation on scales of l mm to 10 m are common in sedimentary rocks. These rhythmic variations include limestone-marl, limestone-black shale, and sandstone-shale alternations. Since evolutionary-uniformitarian scientists believe these sediments were laid down at an excruciatingly slow pace, they have been motivated to look for a slow physical cause for the rhythmicity. With the apparent success of the astronomical theory (proposed by Milankovitch) of the ice age for the Pleistocene period, some geologists have postulated that the Earth's orbital geometry is also the cause of many pre-Pleistocene rhythmites. The main

orbital periods are the approximately 21,000 year precession cycle, the 41,000 year tilt cycle, and the 100,000 and 400,000 year eccentricity cycles.

There is now a large literature allegedly demonstrating by statistical analysis that many pre-Pleistocene rhythmites were laid down according to the Milankovitch periods.[1] For instance, investigators claim that Cambrian 'peritidal' carbonate cycles in the southern Appalachians were probably laid down by the Milankovitch mechanism.[2] A Triassic 'lake' basin in New Jersey is believed to have been filled with evenly-bedded rhythmites for 30 million years due to the Milankovitch mechanism.[3] Geologists have apparently confirmed, as suggested by Wilmot Bradley back in the 1930s, that the Eocene Green River Formation of Wyoming, Utah and Colorado was influenced by Milankovitch cycles,[4] The December, 1991, volume of the **Journal of Sedimentary Petrology** was devoted to studies of pre-Pleistocene Milankovitch cycles.

Geologists arrive at the Milankovitch periods by first dating the sediments, then setting up a time series of bed thickness or lithological change, and finally using spectrum analysis to find the predominant cycles. Spectrum analysis is a statistical programme that analyses the strength of innumerable possible cycles in a time series. The frequencies with the most 'power' are then considered the main causes of the time series. Not only are the Milankovitch frequencies found from spectrum analysis, but they also often find a frequency ratio of 5:1, which supposedly corresponds to the 100,000 year eccentricity cycle and the 21,000 year precession cycle (see Figure 1). These two cycles are related to each other in that the eccentricity cycle determines the amplitude of the precession cycle. The mechanisms suggested for the alternating sediments are sea level fluctuations; periodic variations in carbonate, silica and organic carbon; and cycles of carbonate dissolution. Based on the good statistical results, these studies provide apparent confirmation of Milankovitch cycles as drivers of rhythmic sedimentation as well as the long uniformitarian time-scale.

Not all geologists have jumped on the bandwagon that the astronomical theory is the cause of pre-Pleistocene cyclic sedimentation. A recent paper has strongly questioned that assertion for at least one location.[5] About 600 carbonate cycles of 'Triassic' age in the Alps of northern Italy were claimed to have been laid down in tune with the precession and eccentricity cycles. However, new biostratigraphic and radiometric dates within the uniformitarian paradigm have greatly shortened the time-scale. Instead of each cycle being about 20,000 years long, they are now considered no more than 8,000 years long. Thus, the rhythmic sedimentation and the 5 to 1 bundling could not be due to Milankovitch frequencies:

> *'Precession-induced Milankovitch-band sea-level oscillations are therefore excluded as controls for most of the 600 platform cycles reported from Latemar* [Italy]. '[6]

This underscores the fact that within the uniformitarian paradigm, very accurate dates are required in order to calculate any sedimentation periods, This result for the Italian Alps suggests that other claimed Milankovitch cycles for carbonate oscillations are suspect. A reviewer of the Italian result commented:

> *'A major blow ... to ... the assumption that cyclic shallow-water carbonates are allocyclic and of Milankovitch frequency.'*[1]

Upon further reflection, it is unreasonable to suppose that such a very weak radiational change as the Milankovitch mechanism could cause rhythmites over long periods of geological time and sometimes over large areas. The astronomical theory as the cause of 15 to 30 supposed late Pliocene and Pleistocene ice ages is fraught with problems.[8,,10] That the Milankovitch mechanism is weak is recognised:

> *'Since Milankovitch cycles have only a small seasonal effect, they must be enhanced by climatic-oceanic feedback systems in order to produce a sedimentary signal* [11]

One would think that any significant positive feedback mechanism would be difficult to generate from such weak input. Another problem is that the sedimentary record from a uniformitarian point of view should be too riddled with gaps and overprints from many non-Milankovitch processes, especially for lakes and shallow seas.[12]

For instance, numerous chaotic processes, especially from storms, affect the peritidal environment, and all geological models of this environment are much too simple.[13] Some investigators believe that so many non-

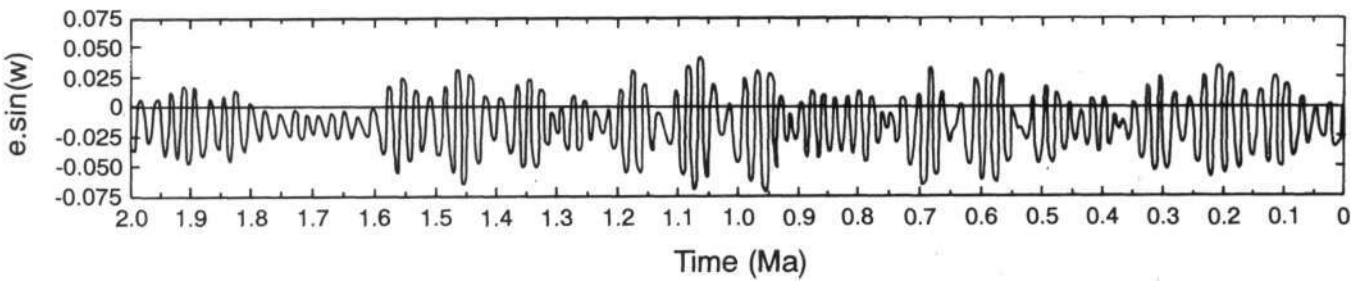

Figure 1. *The variation of the precession of the equinoxes, modulated by the change in the eccentricity of the Earth's orbit.*

periodic processes operate that glacio-eustatic sea level fluctuations during the late Palaeozoic supposed 'ice age' are the only possible amplifying mechanism that could preserve Milankovitch rhythms.[14] Besides all these problems, a uniform sedimentation rate is required over millions of years in order for the spectral analysis to be meaningful.[15]

It seems more reasonable that such evenly-bedded rhythmites, often hundreds of metres thick and covering extensive areas, had to be laid down rapidly. Otherwise, the randomness described by chaos theory would be the rule if the rhythmites were deposited by slow deposition over millions of years. The Flood is an adequate mechanism for rapid rhythmic sedimentation, due either to multiple turbidity currents or, in deep sediment-filled flows, to separation of similar particles during rapid deposition. The latter rhythmic sedimentation has been shown to be possible by Guy Berthault[16] in flume experiments and Steve Austin in observations of rapid sedimentation at Mount St Helens.[17]

It is even possible that carbonate-black shale rhythmites could have been deposited rapidly by the Genesis Flood, since some geologists believe that these rhythmites can be formed by turbidity currents.[18]

REFERENCES

1. Einsele, G., Ricken, W. and Seilacher, A. (eds), 1991. **Cycles and Events in Stratigraphy**, Springer-Verlag, New York.
2. Read, J. R, Koerschner, m, W. P., Osleger, D. A., Bollinger, G. A. and Coruh, C, 1991. Piield and modelling studies of Cambrian carbonate cycles, Virginia Appalachians — reply. **Journal of Sedimentary Petrology, 61**:647-652.
3. Kerr, R. A., 1991. The stately cycles of ancient climate. **Science, 252**:1254-1255.
4. Roehler, H. W., 1993. Eocene climates, depositional environments, and geography, greater Green River Basin, Wyoming, Utah, and Colorado. **U.S. Geological Survey Professional Paper 1506-F**, U.S. Government Printing Office, Washington, D.C.
5. Brack, P., Mundii, R., Oberti, P., Meier, M. and Rieber, N., 1996. Biostratigraphic and radiometric age data question the Milankovitch characteristics of the Latemar cycles (Southern Alps, Italy). **Geology, 24**:371-375.
6. Brack *et al.*, Ref. 5, p. 371.
7. Brack *et al.*, Ref. 5, p. 375.
8. Oard, M. J., 1984. Ice ages: the mystery solved? Part I: The inadequacy of a uniformitarian ice age. **Creation Research Society Quarterly, 21**(2):66-76.
9. Oard, M. J., 1984. Ice ages: the mystery solved? Part II: The manipulation of deep-sea cores. **Creation Research Society Quarterly, 21**(3): 125-137.
10. Oard, M. J., 1985. Ice ages: the mystery solved? Part III: Paleomagnetic stratigraphy and data manipulation. **Creation Research Society Quarterly, 21**(4): 170-181.
11. Einsele, G. and Ricken, W, 1991. Limestone-marl alternations — an overview. *In:* **Cycles and Events in Stratigraphy**, G. Einsele, W. Ricken and A. Seilacher (eds), Springer-Verlag, New York, p. 26.
12. Peper, T. and Cloetingh, S., 1995. Autocyclic perturbations of orbitally forced signals in the sedimentary record. **Geology, 23**:937-940.
13. Nummedal, D., 1991. Shallow marine storm sedimentation — the oceanographic perspective. *In:* **Cycles and Events in Stratigraphy**, G. Einsele, W Ricken and A. Seilacher (eds), Springer-Verlag, New York, pp. 227-248.
14. Algeo, T.J. and Wilkinson, B. H., 1988. Periodicity of mesoscale Phanerozoic sedimentary cycles and the role of Milankovitch orbital modulation. **Journal of Geology, 96**:313-322.
15. Ricken, W, 1991. Variations of sedimentation rates in rhythmically bedded sediments. Distinction between depositional types. *In:* **Cycles and Events in Stratigraphy**, G. Einsele, W. Ricken and A. Seilacher (eds), Springer-Verlag, New York, pp. 186-187.
16. Berthault, G., 1988. Experiments on lamination of sediments, resulting from a periodic graded-bedding subsequent to deposit — a contribution to the explanation of lamination of various sediments and sedimentary rocks. **CEN Tech. J., 3**:25-39.
17. Austin, S. A., 1986. Mount St Helens and catastrophism. *In:* **Proceedings of the First International Conference on Creationism**, R. E. Walsh, C. L. Brooks and R. S. Crowell (eds), Creation Science Pellowship, Pittsburgh, Pennsylvania, Vol. l,pp. 3-9.
18. de Boer, P. L., 1991. Pelagic black shale-carbonate rhythms: orbital forcing and oceanographic response. *In:* **Cycles and Events in Stratigraphy**, G. Einsele, W Ricken and A. Seilacher (eds), Springer-Verlag, New York, p. 65.

M. J. Oard

New Dating Method Calculates Unreasonably Low Rates of Granite Erosion in Australia

Carbon-14 is not the only radioactive isotope formed by cosmic rays. Beryllium-10, half-life 1.5 million years, Aluminium-26, half-life 0.7 million years, and Chlorine-36, half-life 0.3 million years, are three other isotopes also produced. These isotopes are not only formed in the atmosphere, but also come into being when cosmic rays interact with solid objects. The latter three isotopes are referred to as *in situ* cosmogenic radioisotopes and are produced in extremely low quantities because cosmic rays predominantly react in the atmosphere before reaching the Earth's surface. With the advent of accelerator mass spectrometry (AMS), such low quantities of *in situ* cosmogenic radioisotopes, as little as 105 atoms per sample, can now be measured and used for radioisotope dating.[1]

Physicists do not totally understand the formation of *in situ* cosmogenic radioisotopes. Consequently, there are uncertainties in the use of those isotopes for age determination.[23] There are four principal mechanisms for the formation of *in situ* cosmogenic radioisotopes:-

(1) neutron spallation,
(2) muon capture,
(3) neutron activation, and
(4) alpha particle interaction.

It is generally assumed that the neutron spallation mechanism is the most significant. The production rate of cosmogenic radioisotopes on Earth is dependent upon latitude, altitude, and