Appendix 10

Mass Flows

Mass flow or mass movement is a general term for any downslope transport of sediment, rock, or both. The flow can happen either underwater or on the land surface. There are various types of mass flow depending mostly on the type of rock or sediment transported and the amount of water incorporated into the flow.[1] An enormous amount of literature exists on the subject. Uncertainties and much debated still exist over the nature of mass flows.[2] One of the difficulties is geologists must infer the type, characteristic, velocity, etc. of the mass flow from the *deposit*,[3] which is all they have to work with. The deposit only represents the final resting stage of mass flow.

Two Main Types of Mass Flow

There are generally two end members of mass flow: the debris flow and the turbidity current. A debris flow is a moving mass of rock fragments, soil, and mud in which more than half the particles are larger than sand.[4] Of course in a marine environment, there would be no soil. The amount of water in a debris flow is limited. The deposit is called a debrite.

The other end member is the turbidity current, an underwater flow of sediment supported by fluid turbulence. Its deposit is called a turbidite. A turbidity current is believed to contain less than 9% sediments when they are flowing; it is mostly water. However, there is much confusion over the definition of a turbidity current and the products of a turbidity current.[5,6,7]

In-Between Types

A wide range of other types of mass flows are postulated that are somewhere between debris flows and turbidity currents. One of these is a hyperconcentrated flow, which is generally similar to debris flows but with more water.[8] Then there is a "concentrated

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[1] Oard, M.J., 1997. *Ancient Ice Ages or Gigantic Submarine Landslides?* Creation Research Society Books, Chino Valley, AZ, pp. 33–39.

[2] Klaucke, I., D.G. Masson, N.H. Kenyon, and J.V. Gardner, 2004. Sedimentary processes of the lower Monterey Fan channel and channel-mouth lobe. *Marine Geology* 206:181–198.

[3] Mulder, T. and J. Alexander, 2001. The physical character of subaqueous sedimentary density flows and their deposits. *Sedimentology* 48:269–299.

[4] Neuendorf, K.K.E., J.P. Mehl, Jr., and J.A. Jackson, 2005. *Glossary of Geology*, Fifth Edition. American Geological Institute, Alexandria, VA, pp. 165–166.

[5] Shanmugam, G., 1996. High-density turbidity currents: Are they sandy debris flows? *Journal of Sedimentary Research* 66:2–10.

[6] Shanmugam, G., 1997. The Bouma sequence and the turbidite mind set. *Earth-Science Reviews* 42:201–229.

[7] Shanmugam, G., 2000. 50 years of the turbidite paradigm (1950s—1990s): Deep-water processes and facies models—A critical perspective. *Marine and Petroleum Geology* 17:285–342.

[8] Shanmugam, Ref. 7, p. 301.

density flow" that contains more sediment than a turbidity current, but less than a hyper-concentrated or debris flow. It is believed to be responsible by some scientist for carving and/or deepening submarine canyons (see Volume III).[9,10]

It is well known that during a mass flow, the type of mass flow can transform from one type to another. For example, a debris flow can transition into a turbidity current with the addition of water, and vice versa. These transformations can occur several times during one mass flow. In addition, a flow of water carrying rocks along its bottom can become a turbidity current or a debris flow or anything in between with the addition of more rock and sediments. The reverse can also happen: a mass flow can transform into a flow of water after the sediments and rocks are deposited.

Mass Flow Associated with Quartzite Rock Transport

In regard to the quartzite rocks found in the northwest states, they are so well rounded with high-impact percussion marks that it is likely the quartzite formations were mostly transported by water.[11] Along the path, the Flood currents were also eroding other, softer rocks, resulting in finer-grained debris being added to the quartzite rocks during transport. So much other debris would have been added in some places, that the watery flow would transform into a type of mass flow and be deposited as a mass flow. This is probably why there are a lot of finer-grained particles in some quartzite deposits. Some quartzites seem to be floating within fine-grained particles, the later classified as a debrite.

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[9] Mulder, T. and J. Alexander, 2001. The physical character of subaqueous sedimentary density flows and their deposits. *Sedimentology* 48:269–299.

[10] Mulder, T., B. Savoye, and J.P.M. Syvitski, 1997. Numerical modelling of a mid-sized gravity flow: the 1979 Nice turbidity current (dynamics, processes, sediment budget and seafloor impact). *Sedimentology* 44:305–326.

[11] Klevberg, P. and M.J. Oard, 1998. Paleohydrology of the Cypress Hills Formation and Flaxville gravel. In, Walsh, R.E. (editor), *Proceedings of the Fourth International Conference on Creationism*, technical symposium sessions, Creation Science Fellowship, Pittsburgh, PA, pp. 361–378.