CENOZOIC AND QUATERNARY GREAT CRATERING EVENTS (WITH EJECTION OF TEKTITES) COINCIDED WITH SUDDEN SHIFTS IN ABSOLUTE MOTION OF THE PACIFIC PLATE AND SUDDEN SHIFTS IN THERMAL AND ISOTOPIC EVOLUTION OF THE PACIFIC OCEAN. L. O. Nicolaysen, Bernard Price Institute of Geophysics, University of the Witwatersrand, Wits 2050, South Africa.

Wessel and Kroenke[1] computed the times of sudden change in the absolute motion of the Pacific plate from the satellite-derived record of sea floor topography, the spreading history and the notion that fixed plumes upwelling from a strong deeper mantle are responsible for Pacific seamount chains.

High resolution records of Pacific deep ocean Pb isotopic evolution[2] , during the Tertiary and Quaternary, and the records of benthic temperature evolution at sites nearby, both have a crudely “sawtooth” character; these major “sawtooth” features (including turning points) are essentially synchronous across both Pb isotope ratios and temperature. Four crudely “sawtooth” shapes dominated the past 53 million years and about six such shapes dominated the past 65 million years.

Strikingly, a switch from sea water warming to pronounced and continued sea water cooling coincides with a crisis involving (a) a sudden shift in absolute motion of the Pacific plate (b) rapid effusion of flood basalt (c) important cratering event resulting in ejection of tektites (d) enhanced orbital pulsing of the sea water parameters. Evidently each “sawtooth”, or bistable sequence in seawater evolution is separated from the next “sawtooth” by a crisis. Thus, secular change within the Cenozoic and Quaternary Eras can be viewed as an orderly succession: crisis → sea water cooling → sea water warming → crisis → sea water cooling → sea water warming → etc.

To understand the great cratering events and tektites, there is an urgent need to understand the orderly succession of bistable sequences and crises. The shell between 350 km and 750 km depth, - the mid-mantle – and the physics whereby volatiles ascend through this shell, are vital.

First: some basic points made by Green et al[3]. Slabs subducted into this shell carry down enough C and DHMs to saturate the shell with C-O-H fluid. This mid-mantle fluid is carbonatitic, like the fluid in Jwaneng diamonds. Low oxygen fugacity of the fluid ensures that most of the shell is sub-solidus. In our view, there is sufficient strength and porosity at short characteristic times to show aquifer-like behavior, but major slab-like masses simultaneously participate in convection (with much greater characteristic times). Lower mantle isotopic signatures characterize the deep noble gases. Because elastic stresses are highest in the mid-mantle, when C-O-H pore fluids and noble gases escape from poro- elastic storage, they drive ascent of a plume. Flood basalts and great cratering are thus profoundly linked: atop volatile-driven plumes.

During a time interval of ~6 my, a spherical front (which involves compaction of the aquifer) diffuses inward across the shell[4] , and the C-O-H pore fluid is expelled outward. During the next ~6 my time interval, a spherical front (which involves inflation) diffuses outward across the shell, and the shell “fills up” with pore fluid[5] . The workings of the aquifer-like shell are therefore functionally bistable; turning points or crises are inherent in the geodynamic functioning of this shell, occurring when the inward transit of a front of compaction across the shell terminates. The subducting slabs permit efficient shuttling of greenhouse fluid between pore-elastic storage (in the porosity of the mid-mantle aquifer) and ocean-atmosphere storage. Shuttling ensures strong linkage between the mid-mantle’s bistable workings and the bistable thermal and isotopic evolution of central Pacific seawater.

Conclusion: The Terminal Cretaceous, near-Terminal Eocene, 15.5 my (Ries) event, 3 my event, australite event, all involved catastrophic cratering, but these catastrophes were just brief, hypervolcanic moments in larger orderly bistable sequences, played out simultaneously every ~12 my, and affecting diverse earth sciences.

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References: [1] Wessel, P. and Koenkel L. Nature 387, 365-369, 1997. [2] Christensen, J.N. etl al., Science 277, 913-918, 1997. [3] Green D.H. et al., Nature, 365, 1993. [4] Mason, D.P. et al., J. Appl. Phys. 70, 4724-4740, 1991. [5] A. Solomon et al., Int. Jour. for Numerical and Analytical Methods in Geomechanics 17, 699-714, 1993.