SURGE THEORY WEIGHS IN ON THE BALANCE OF EVIDENCE IN THE DEBATE ON GLOBAL WARMING

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SUMMARY

Walker's observations reported in the article, ***Seismic Predictors of El Nino Revisited,*** correlate increased T-phase seismicity along the East Pacific Rise (EPR) as a precursor to El Nino events. Associated phenomena preceded by seismic activity include episodic seafloor spreading and reduced pressure in the high-pressure cell of the Southern Oscillation (SO). These observations repeated seven times since 1964 in a pattern unexplained by current geophysical theory. Two counterclockwise-rotating microplates along the EPR, the Easter and Juan Fernandez microplates, are considered to be driven by downwelling tectonic vortices, as explained by a more recent geophysical theory known as the surge tectonic hypothesis. These twin microplates underlie the high-pressure cell of the SO associated with El Nino. The tectonic vortices may be directly responsible for the pressure changes as they shape-shift from global-scale geoid undulations. Shape-shifts create density oscillations within a vortex and may account for local microgravity change. This mechanism is analogous to pressure changes in atmospheric vortices, like tornadoes and hurricanes, which are known to affect local microgravity. Approximately 0.33 ***u***gal/mbar (gravity field to atmospheric pressure change) has been demonstrated and quantified as early as 1977 by Warburton and Goodkind using superconducting gravity meters. The "missing link" between seismicity and El Nino may well be tectonic microgravity-induced atmospheric pressure change or gravitational teleconnection. This mechanism for tectonic coupling to atmospheric pressure oscillations through tectonic vortices may explain El Nino Southern Oscillation (ENSO), a known teleconnection of other parameters such as sea surface temperature and sea-level pressure. The Central Pacific Megatrend (CPM) connects planetary-scale tectonic vortices underlying the ENSO pressure cells. It connects the microplates on the EPR across basin to the Banda Sea tectonic vortex. The Banda Sea is a plate triple junction (between the Australian, Pacific, and the Southeast Asian plates) just north of Darwin, and it underlies the low-pressure cell of ENSO. Active surge channels or geostreams defined by the newer surge model link these planetary-scale tectonic vortices. The geodynamic circulation pattern based on the newer model is similar to Walker circulation patterns known in atmospheric models. Sir Gilbert Walker (Walker, 1924; Walker and Bliss, 1932) first observed sea-level pressure variations of the SO teleconnection in the 1920's. Based on new insights, a pilot study with cryogenic superconducting gravity meters placed near the twin microplates may detect the driving forces behind ENSO. The orders of magnitude involved seem plausible and, if experimentally proven, would open new corridors of climate research, alleviating the focus on greenhouse gases as the primary source of climate change. Failure to explain the El Nino link to seismicity casts doubt that the debate on "the human contribution to climate change" will ever be clearly resolved. Dedicating research funds allocated to global warming issues can be justified based on Walker's observations alone, and research can be implemented by the Ridge Inter-Disciplinary Global Experiments (RIDGE) and Ocean Mantle Dynamics (OMD) science plans. These are National Science Foundation initiatives that foster interdisciplinary scientific study of mid-ocean ridge processes.

INTRODUCTION

EVIDENCE FOR TECTONIC LINK TO CLIMATE

Since 1964, there has been almost four decades of extensive work (Walker, 1988; 1995; 1999; Walker and Hammond, 1990) on T-phase (teleseismic signals detected by hydrophone arrays placed in the ocean's acoustic wave-guides) seismicity in the Pacific. This work documents earthquakes along spreading ridges occurring in swarms along hundreds of kilometers. Specifically, these earthquakes occur along the East Pacific Rise (EPR) near Easter and Juan Fernandez microplates (Fig. 1). These earthquakes are associated with hydrothermal venting, magma outpourings, and atmospheric high-index pressure phases of Southern Oscillation Index (SOI) and indicate a swelling of the entire ridge along the plate boundary. Walker found earthquakes associated with these intense episodes of seafloor spreading are precursors to the reduced atmospheric pressure in the El Nino Southern Oscillation (ENSO) high-pressure cell over Easter Island. These observations repeated seven times since 1964 in a pattern unexplained by current geophysical theory. His 1999 article considers the energy transfer mechanism for the correlation between earthquake activity and the atmospheric pressure drop to possibly be microgravity, as suggested by Leybourne in 1996.

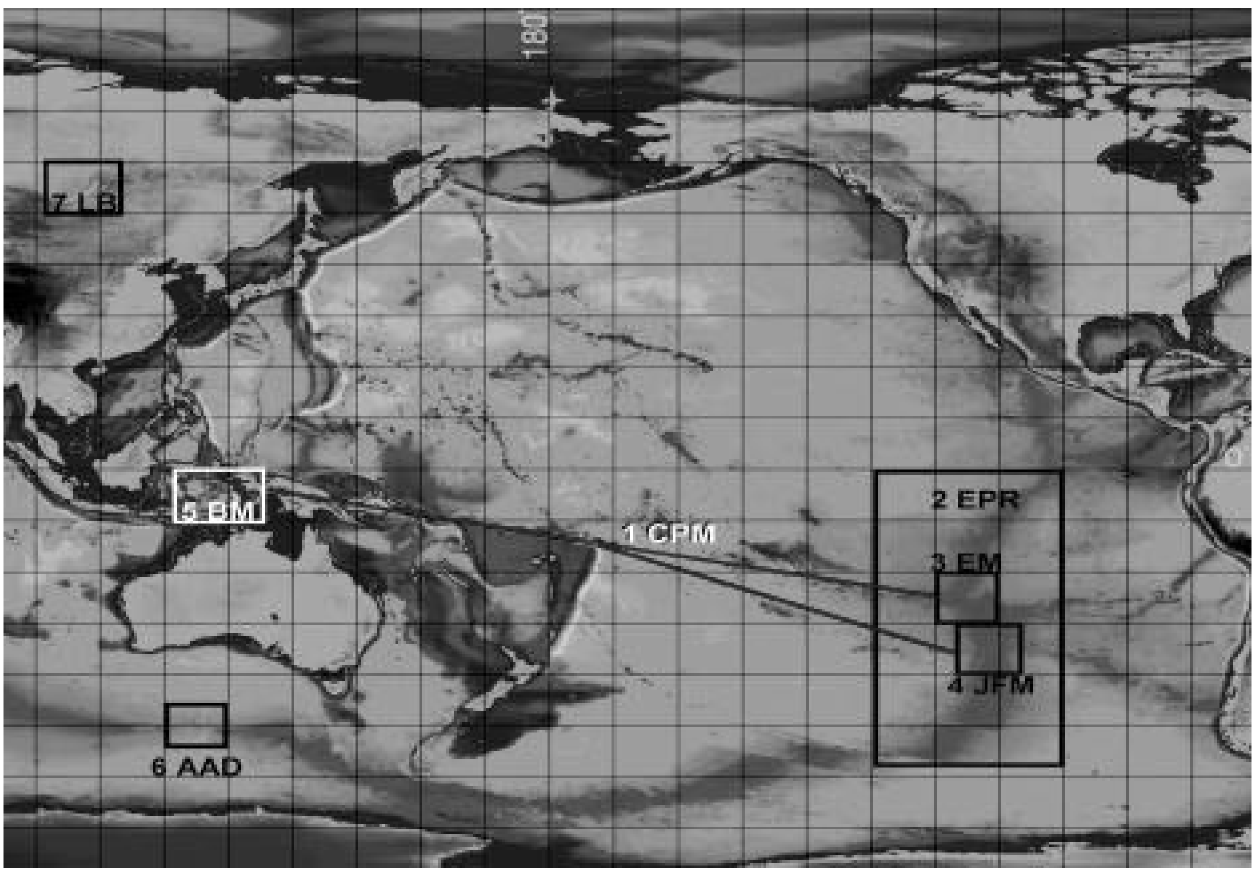

Fig. 1. Location Map: 1. Central Pacific Megatrend (CPM); 2. East Pacific Rise (EPR); 3. Easter Microplate (EM); 4. Juan Fernandez Microplate (JFM); 5. Banda Microplate (BM); 6. Australian-Antarctic Discordance (AAD); 7. Lake Baikal (LB). Inserts 3 – 7 are Tectonic Vortices Discussed (NAVOCEANO).

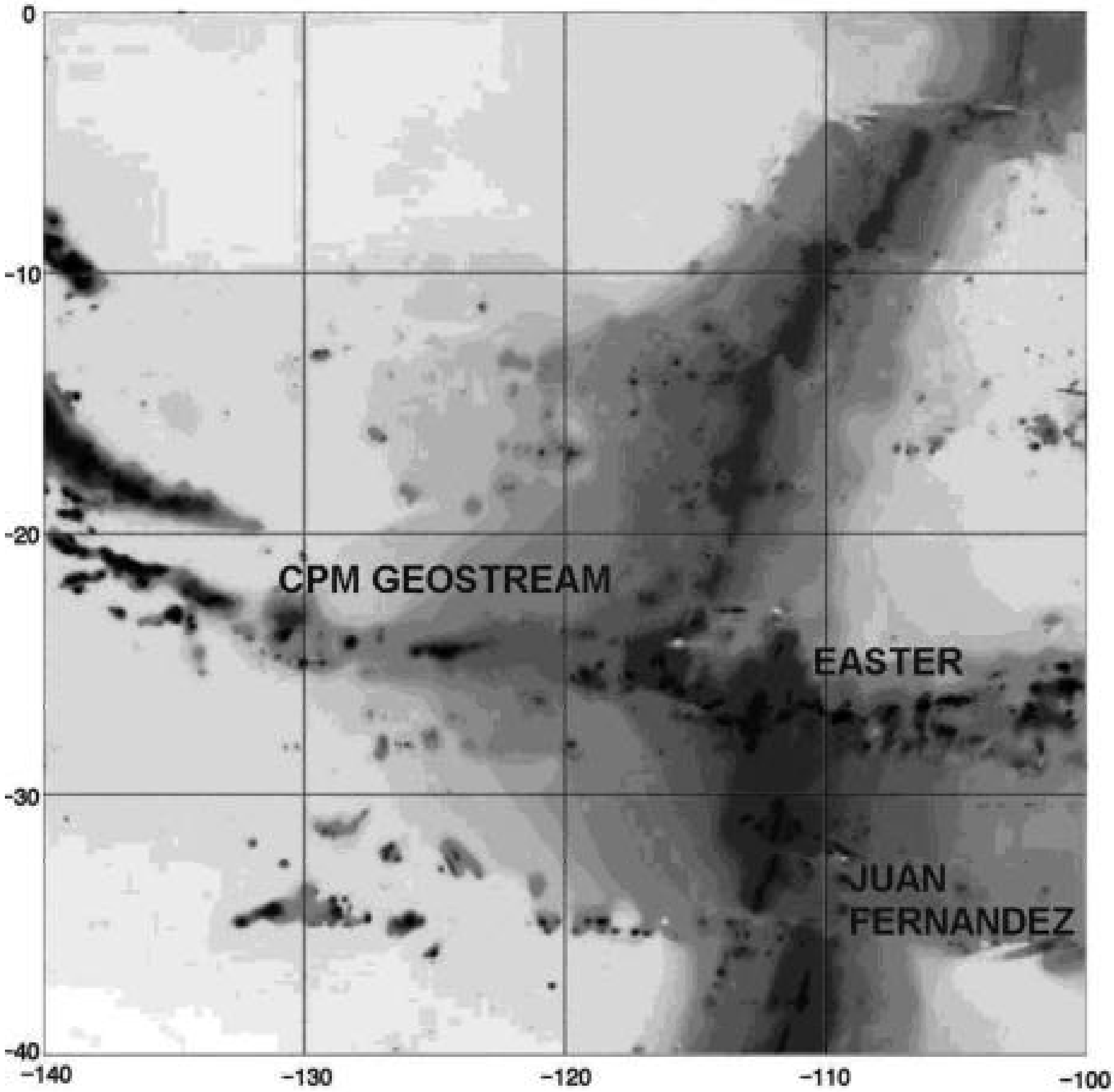

Fig 2. Bathymetry of East Pacific Rise near Easter and Juan Fernandez Microplates. Note area off Ridge Island Chains Indicating Incoming Geostreams from the Central Pacific Megatrend (NAVOCEANO).

GEOSTREAM SURGE THEORY

NEW GEOPHYSICAL INTERPRETATION

The Easter and Juan Fernandez microplates (Fig. 2), rotate clockwise on the EPR (Searle et al., 1989; Larson et al., 1992; Bird, 1994). They are considered to be driven by downwelling tectonic vortices (Fig. 3a and Fig. 3b, Source: Major Shared Resource Center-MSRC), as explained by a more recent geophysical theory known as the surge tectonic hypothesis (Meyerhoff, et al., 1992, 1996). These twin vortices underlie the high-pressure cell of the Southern Oscillation (SO) associated with El Nino. The Central Pacific Megatrend (CPM) (Smoot and Leybourne, 2001, in press, Fig. 1 and Fig. 2) connects planetary-scale tectonic vortices underlying the ENSO pressure cells (Leybourne, 1998a).

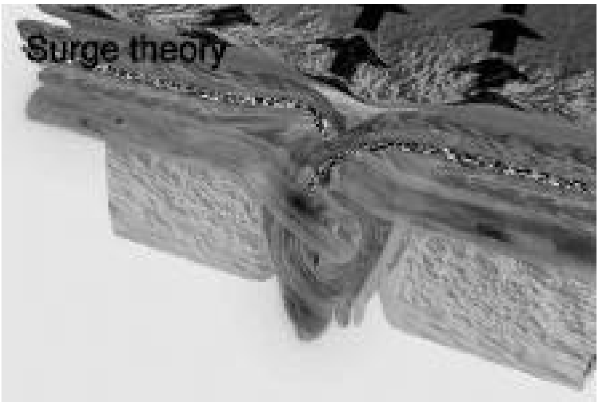

Fig. 3a. Generic Downwelling Vortex Underlies Easter and Juan Fernandez Microplates. Arrows Represent Spreading Direction from Geostream Contraction/Expansion or Surges (MSRC).

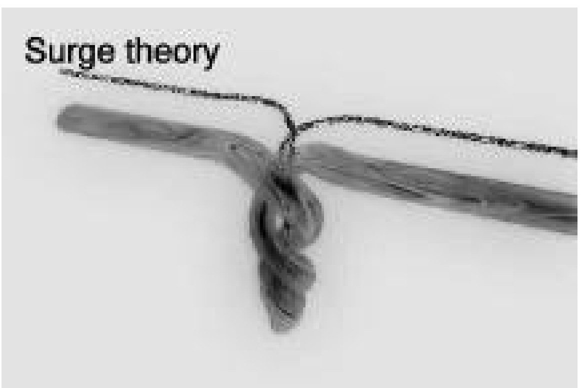

Fig. 3b. Thin Upper Line Represents Asthenosphere Axial Counterflow Flow and Explains why no Narrow Focused Zone of Upwelling along the Ridge from the Deep Mantle was Found in Ridge Experiments (MSRC).

The path of the CPM begins in the Banda Sea region and passes through structural features of Irian-Jaya, the Van Rees, and the Maoke Mountains of New Guinea. The Banda Sea is a plate triple junction (between the Australian, Pacific, and Southeast Asian plates) just north of Darwin and is considered an upwelling mantle vortex (Fig. 4a and Fig. 4b) underlying the low-pressure cell of ENSO (Leybourne and Adams, 1999). The CPM then continues along the north of the western Pacific trenches through the southern portion of the Ontong-Java Plateau. The Vityaz Trench System then extends over 2500 km in the form of the Kilinailau, the North Solomon, the Ulawan, and the Cape Johnson trenches. The megatrend appears to splay eastward along a flowing magma regime. The Galapagos Fracture Zone gets a fresh infusion of magma from the active Line Islands that run south-southeast at the Tuamotu Ridge, and the zone diverts eastward as a massive ridge which changes to the north fork of the Easter Fracture Zone. This trend continues to the Easter microplate, or vortex structures on the EPR. It connects the EPR across basin to the Banda Sea tectonic vortex.

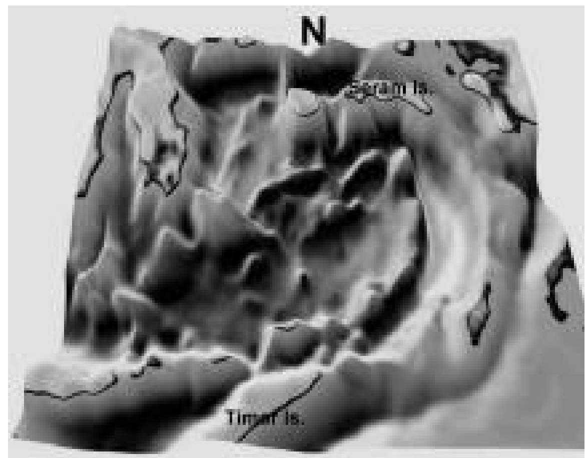

Fig. 4a. Note Hurricane Symbol in Bathymetry of Banda Microplate. The Asthenosphere Counterflow Upwells in the Central Vortex Flowing Westward along Indonesian Island Arc (NAVOCEANO).

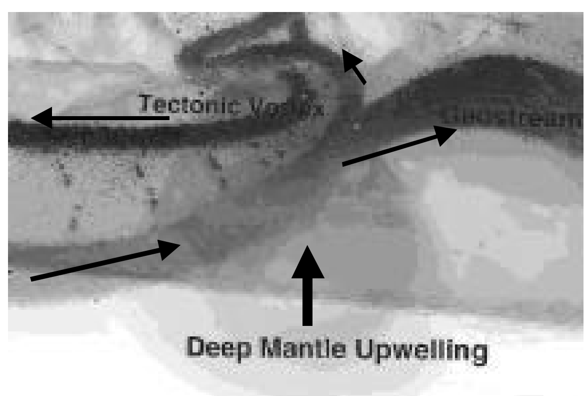

Fig. 4b. Artist Conceptualization Under Seafloor of Deep Mantle Upwelling and Stream Flow Hypothesized to Form Banda Vortex Geomorphology. Viewing Direction North Same as Fig. 4a. (MSRC).

Active surge channels, or "geostreams," defined by the newer surge model link these planetary-scale tectonic vortices. The original lead for a trans-Pacific megatrend was from the works of the late A.A. Meyerhoff. He brought this region to attention with the publication ***of Surge Tectonics: A New Hypothesis of Earth Dynamics*** in 1992. This insight was based on his many years of field study for oil exploration in Southeast Asia, the former USSR, and China, as well as his background in fluid dynamics. Additional evidence of the CPM includes first-order trends of high-pass-filtered satellite altimetry data from the Geodetic Earth-Orbiting Satellite (GEOSAT, Fig. 5), revealing across-basin trends in the gravity geoid (Sandwell et al., 1995; Leybourne and Smoot, 1997; Smoot, 1999). Also there is seismicity within the interior of the Pacific midbasin established with T-phase seismic hydrophone arrays (Walker, 1989).

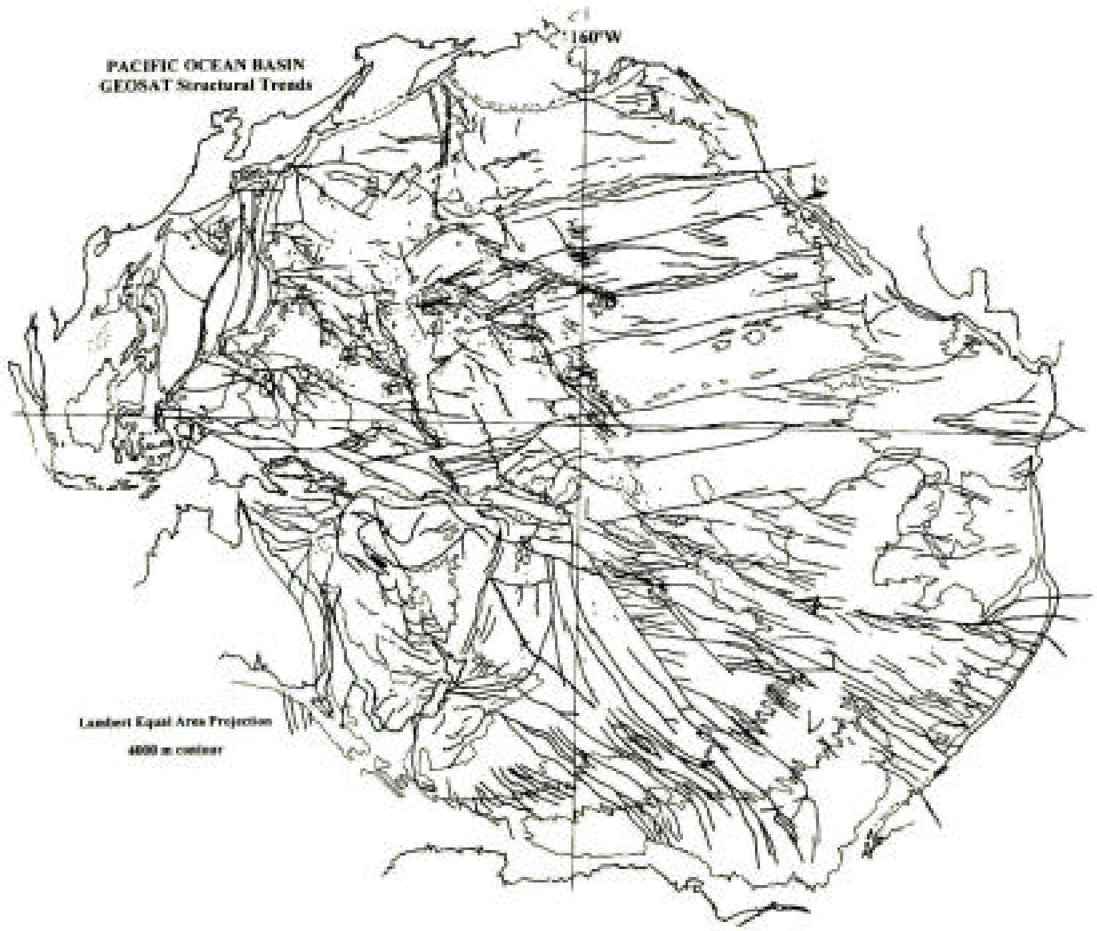

Fig. 5. Pacific Ocean Basin Structural Trends Based on High-Pass Filtered GEOSAT Data in Lambert Equal Area Projection. Follow the Central Pacific Megatrend from the Banda to East Pacific Rise Vortices and Note Eastward Splaying. Compiled by Smoot in 1995 (Smoot and Leybourne, 1997).

Plate tectonic investigators must use ad hoc explanations for the CPM and to explain several other lines of geological evidence. Paleoclimatic data, specifically the distribution of ancient evaporites, carbonate rocks, coals, and tillites, along with fossil faunas and floras indicate the present position of the rotational axis, continents, and ocean basins have been fairly constant somewhere between 570–1,600 million years (Meyerhoff and Meyerhoff, 1972a). Another remarkable line of evidence is undeformed sediment in many island arc trench fills and fracture zones crossing the ridges. These sediment layers should be deformed substantially if subduction and seafloor spreading take place, as plate theory purports (Meyerhoff and Meyerhoff, 1972a; Choi, 1997).

A CASE FOR GEOSTREAM FLOW AND VORTEX ANALYSIS

Easter Island and Juan Fernandez microplate rotations are driven by shear along the edges from relative motion of the surrounding major plates (Pacific, Nazca, and Antarctic plates) like roller bearing, as interpreted with the plate tectonic hypothesis (Searle et al., 1989; Larson et al., 1992; Bird, 1994). Larson et al. state, “Enclosing the core of the microplate, the inner pseudofaults form a pattern resembling the meteorological symbol for a hurricane.” While Bird states, “The result is a feature that appears much like a geological “hurricane” embedded in the crust of the earth.” These references to the Juan Fernandez microplate belie the significance of the surge tectonic interpretation of these features as tectonic vortices (Fig. 3a and 3b). Basic fluid dynamics can be applied based on surge theory. The difference in a surge interpretation is that these features represent high-pressure or downwelling tectonic vortices as opposed to the low-pressure upwelling of a hurricane mentioned above. The reasoning is based on atmospheric dynamics, where high pressure is counterclockwise in the southern hemisphere, and a well-defined high has a characteristic upper-level low with opposite spin, or clockwise rotation like the microplates exhibit. In the opposite sense it is well known that an upper-level high is necessary for development of the low pressures in hurricane formation. If the upper-level high is sheared, hurricanes weaken.

EVIDENCE OF DOWNWELLING ON RIDGE

Gravity studies undertaken in conjunction with a wide-angle seismic refraction survey during the Mantle Electromagnetic and Tomography (MELT) experiment find evidence for denser, colder mantle near a small Over-lapping Spreading Center (OSC) on the East Pacific Rise (EPR) at approximately 15^{o} 55’ S (Forsyth, et al., 1998). The direct quote from page 1217 is, “Wide-angle seismic refraction data recorded on secondary Ocean Bottom Seismic (OBS) array show that crustal thickness and structure near this small OSC is normal. Therefore, the gravity anomaly probably is caused by denser and perhaps colder mantle near the OSC. ***P*** and ***S*** wave arrivals from teleseismic earthquakes are earlier along the secondary array than at comparable distances from the axis in the primary array, consistent with lower temperatures or lower melt fractions near the OSC. Finally, Rayleigh wave phase velocities show a pronounced, along-axis increase beginning in the vicinity of the OSC, suggesting that melt concentrations are lower beneath the OSC and northward.” This evidence is contrary to upwelling mantle under a ridge, which should be hotter and less dense, characteristics of a buoyant mantle. No attempt is made by investigators to explain this contrary piece of evidence or incorporate it into any modeling efforts. The data are basically reported, but ignored. This is a reminder of the humorous adage field data collectors sometimes use in reference to in-house modelers, in that “if the data doesn’t fit the model something must be wrong with the data.” Of course in this case nothing is wrong with the data:; it is irrefutable: the mantle is denser under the OSC. How could the mantle possibly downwell under the ridge, especially in the vicinity of an OSC, where all plate tectonic models predict mantle upwelling? The answer is found with a surge tectonic interpretation of converging mantle flow along-axis under a pressurized ridge. The ridge pressure forces denser mantle downward and volatile magmas upward in a counter-flow pattern very similar to atmospheric dynamics*.*

FLAWED THEORY 180 DEGRESS OUT OF PHASE

Mantle geostreams converge from the north and south along the EPR axis in addition to the across-basin convergence from the CPM to pressurize the EPR. This pressure induces mantle downwelling within overlapping spreading centers of the microplates. Mantle stream-lines are defined by the ridge axis and mantle sinks into the Endeavor Deep of Juan Fernandez microplate and the Pito Deep of Easter microplate. Asthenosphere counterflow generated in the upper-level low flows opposite the mantle and supplies magmas to the volcanoes and ridge system (Fig 3a, 3b, and 4b). This geodynamic interpretation is based on atmospheric dynamics or basic fluid dynamics and explains the rotation of the microplates and underlying geomorphology. If this model proves correct, it points out the basic flaw in the plate tectonic concept. The flaw is that the mantle flow dynamic of plate tectonics along ridges is 180 degrees out of phase with reality. There is no linear upwelling of mantle at the ridge along a crack in the plates, but instead there is horizontal mantle flow along the ridge axis with discrete downwelling within vortices along pressurized zones of the ridge. Counterflow (an exhibition of Newton's third law of motion observed in many fluids) to the mantle creates interconnected magma chambers in the asthenosphere. Surges within these interconnected magma chambers, also called geostreams or surge channels, produce extrusions of volcanic rocks. This principle not only applies to ridge systems, but also to continental rifts and island arcs. It may be applied globally without ad hoc interjections. Pressure variations in magnitude and direction (up vs. down) within different systems explain differing geomorphology.

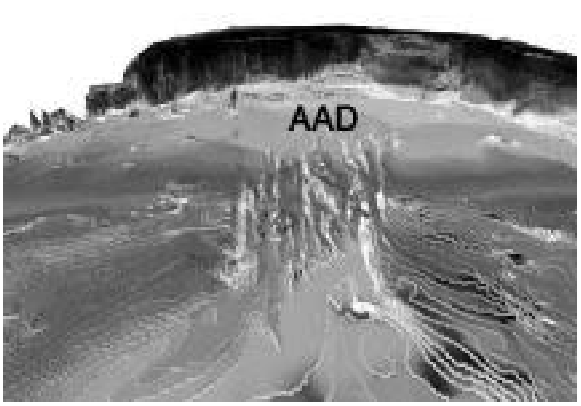

Fig. 6a. Bathymetry of the AAD Looking North Indicating 1km drop over 600km expanse and Modeled as Downwelling Zone with Converging Axial Flow as early as the 1970's (NAVOCEANO).

GLOBAL APPLICATION OF SURGE

The EPR is the most highly pressurized ridge on earth and exhibits a positive bathymetric profile with high spreading rates. Other ridges have similar flow dynamics, but exhibit different geomorphology due to different pressures. The Mid-Atlantic Ridge is depressurized and exhibits a negative bathymetric profile and slower spreading rates. The Southeast Indian Ridge exhibits a positive bathymetric profile with intermediate spreading rates, except at the Australian-Antarctic Discordance (AAD, Fig. 1), where a depressurized zone exhibits a negative bathymetric profile (Fig. 6a). The AAD can also be modeled as a vortex (Fig. 6b) with converging flow along the ridge axis. Reduced pressure causes a negative bathymetric profile along the ridge, approximately 1 km deeper over a 600km expanse (Leybourne and Adams, 2000).

Variations of a converging axial flow model for the AAD were proposed as early 1973 (Vogt and Johnson, 1973; Vogt, 1976; Alvarez, 1982; 1990; Vogt et. al., 1983; Forsyth et al., 1987; Klein, 1988; Kuo, 1993), but flows around the plates are seen to be a refinement of the plate tectonic model even though downwelling at the ridge axis is 180 degrees out of phase with the proposed plate concept. Interpretations of the AAD are really based on the tenets of surge theory, but unwittingly are blatant examples of the ad hoc refinements used to fit geophysical observations into plate theory instead of using a theory that fits the observations.

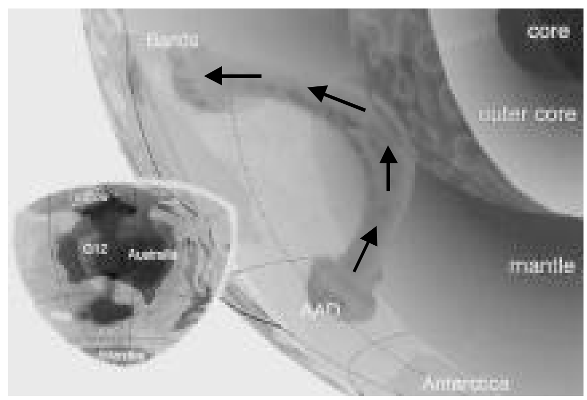

Fig. 6b. Arrows Denote Deep Convection Connection Under Australia is 180 Degrees out of Phase with the Plate Tectonic Concept (MSRC).

Within the framework of surge interpretation, ridges appear to be dominated by downwelling mantle vortices along overlapping spreading centers and possibly at transform offsets. Island arcs, on the other hand, appear to be dominated by upwelling mantle vortices from under the continents, exemplified by formation of island arcs predominantly eastward of landmasses and crustal isostatic compensation to upwelling by trench formation in the arcs. Geostreams generally move eastward like jetstream patterns because of earth rotation, although ocean basins seem to be dominated by north/south meridian flow at the ridges. Continental geostreams are represented by mountain ranges and continental rift areas and are interconnected directly to ocean basins along tectonic trends in a Global Earth Teleconnected Oscillation System (GETOS). This includes the Southern Oscillation (SO), the North Pacific Oscillation (NPO), and the North Atlantic Oscillation (NAO), all of which are ocean/atmospheric teleconnection patterns underlain by and coupled to major tectonic vortices by microgravity.

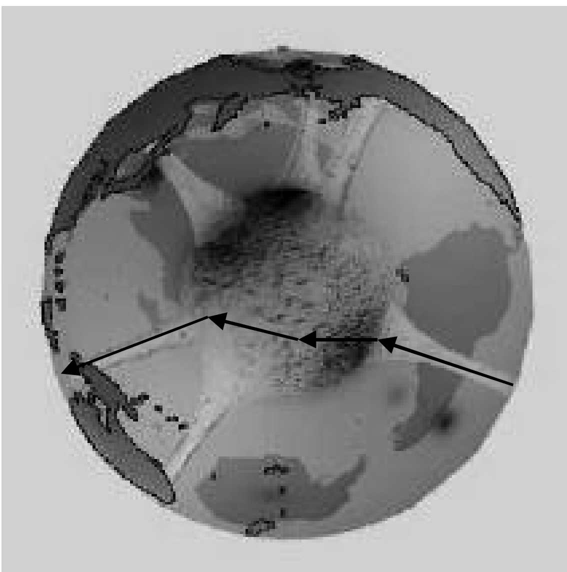

Fig. 7. Conceptually Simplified Deep Mantle Planetary Scale Convection Cells Globally Teleconnected to the Outer Core. Arrows Denote Banda and East Pacific Rise Deep Mantle Walker Circulation (MSRC).

Surge theory allows atmospheric 3-D circulation patterns, such as Walker Circulation, to be considered as a model for tectonic dynamics in the Pacific Basin instead of only simple Hadley Cell 2-D convection, considered as a driving force in plate tectonics. Once this simple shift in perspective is made it is fairly easy to understand how large downwelling tectonic pressure cells along offsets on the EPR are dynamically linked to mantle upwelling in the Banda Sea tectonic vortex (Fig. 7). Upper mantle stream flow processes across the Pacific Basin, along the CPM, and around the Pacific “Rim of Fire” diverge (Fig. 4b) under the Banda Sea. Divergence also occurs north of New Zealand within other tectonic vortices farther along the CPM vortex street (Smoot and Leybourne, 1997). These geostreams all converge on the EPR, and have a deep planetary-scale vortex connection near the outer core (Fig. 7). These convection components complete a simple Walker Circulation model for the tectonics of the Pacific Basin. A Banda Sea surge model is portrayed by Leybourne and Adams (1999).

Finally a note of interest is the westward drift in sequential, 5-year intervals in the World Magnetic Models (WMM). This agrees with the surge concept of westward drift in the deep mantle as a counterflow to upper mantle eastward flowing geostreams, exactly analogous to eastward jetstreams and westward trade winds. Although inconclusive and untenable, this interesting geophysical observation is yet another small piece of evidence that seems to fall into place with the newer surge model.

GRAVITATIONAL TELECONNECTION

TECTONIC MODULATION OF CLIMATE

The surge hypothesis implies gravitational teleconnection of tectonics to climate (Leybourne and Smoot, 2000). It takes very little change in microgravity (0.3-0.4 ***u***gals/mbar or approximately 1***u***gal for every 3mbars) to produce atmospheric pressure flux of one mbar. This relationship has been demonstrated and quantified (Warburton and Goodkind, 1977) using superconducting gravity meters. Microgravity changes of 6***u***gals were noted for typical weather patterns with maximum shifts up to 45***u***gals. Inversely, this means small regional atmospheric fluxes of the SO, which are approximately 4-6mbars, may be explained with only a 2***u***gal change within a regional-scale tectonic vortex. Are tectonic dynamics capable of producing microgravity shifts of this magnitude? Francis et al. (1997) document a 17***u***gal shift in the gravity field over an approximate 6-month period with superconducting gravity meters moving through Membach, Belgium. They attribute this shift completely to geophysical origin. This 17***u***gal shift, which moved through Europe in early 1996, may also be related to the 1997/98 El Nino if it migrated toward the Pacific Basin as a slow-moving microgravity wave caused by geoid undulations. It also follows that increases in hurricanes in the Atlantic after an El Nino may be explained by eastward migration of microgravity waves. Modulation of jetstream patterns by across-basin sea-level pressure oscillations is the common denominator between large-scale global climate changes and the large variation in the number of hurricanes formed within the Atlantic from year to year.

Earth scientists generally accept that global eustatic sea-level changes of various magnitudes and duration have various origins. Tectonics as a driving force for climate change has previously been considered for Supercontinental Gondwanaland-type plate collisions and tectonic rifting cycles on the order of 10^8 years (Fairbridge, 1982). Changes in seafloor spreading rates and mid-ocean ridge volumetric expansion/contraction are hypothesized to have tectonic cycles on the order of 10^7 years (Koming, 1984, Pitman, 1978). Sedimentary depositional cyclicity has been recorded throughout the Phanerozoic in seismic sequences at periods of 10^5 and 10^6 years and are known as Milankovitch series correlations.

MILANKOVITCH SERIES CORRELATIONS

Planetary orbital motions altering the radius between earth and sun control the amount of incoming solar radiation of 20,000-, 40,000-, and 100,000-, year duration (Milankovitch series correlation). The apparent cause of these 10^5 and 10^6 depositional cycles affecting climate/sea-level fluctuations is solar insolation changes due to the orbital parameters, as opposed to tectonic fluctuation, which is considered a separate mechanism. What if they are not completely separate mechanisms?

Milankovitch's original concept (Milankovitch, 1941) is that the orbital position of the planet controls the amount of incoming solar energy, thus controlling long-term climate trends. Three principal orbital parameters affect low-frequency oscillations of the Earth's size and shape. Eccentricity (100,000-year cycles) is the deviation of the orbit from a perfect circle; obliquity (40,000-year cycles) is the angle of tilt of the Earth's axis with respect to the plane of its orbit; and precession (26,000-year cycles) is the direction in which the rotation axis points. Interactions between principal orbital parameters control much long-term climate change. The dominance of eccentricity has been linked to glacial cycles. The similarity between the duration of major glacial cycles, such as those of the past 800,000 years, and the duration of eccentricity cycles imply a causal relationship (Berger, 1980; Berger et al., 1984). Such orbital periodicities have been found in deep-sea cores (Hays et al., 1976; Berger et al., 1984).

Even though first-order mechanisms of climate change may be separate volumetric expansion/contraction of ridges versus solar isolation flux, what if these mechanisms are linked by microgravity modulation of atmospheric pressure through tectonic vorticies? Tectonic and solar changes in addition to planetary alignments and intergalactic or possibly interstellar events may all alter microgravity at various magnitudes and time scales. Arguments that solar insolation variations caused by relatively short-term sunspot activity have higher magnitudes than those induced by orbital parameters may point to a more complex mechanism at work than solar insolation alone, as stated in Milankovitch series correlations (Leybourne, 1998b). Variations in height of lake levels in the Middle East, like the Caspian, have been linked to sunspot activity, (Rodionov, 1994) but the phase is not consistent. This mysterious climate link may be explained by variations in the magnitude of gravitational teleconnection which alter storm tracks dependent on tectonic vortex teleconnection strength. When the effect of tectonic gravitational teleconnection on atmospheric flow dynamics is considered, a much more powerful concept for the drastic changes observed in climatic proxies emerges. This concept links all eustatic sea level and climate change to tectonic dynamics, including modern-day high-frequency variations of El Nino cycles. Shifting wind patterns, especially the jet streams meridional to zonal perturbations, may be controlled by GETOS. If this effect dominates the modern climatic swings of El Nino, logic implies that larger changes recorded in climate proxies are a result of more dramatic changes in these modern processes. These processes may be quantified and modeled using accurate time-series microgravity data collected within the tectonic vortices of GETOS.

The tectonic gravitational teleconnection modulation hypothesis enhances Milankovitch series correlation with climatic shifts, especially in light of the argument that orbital changes of radius between the earth and sun alone correlated to temperature change are not enough to explain the degree of climatic change observed in the geologic record. Local changes in "g" induced from undulations in the sun, the earth, or planetary alignments could invoke a weakening or strengthening of microgravitational teleconnection between tectonic vortices, thus shifting jetstream patterns globally.

DISCUSSION

THEORY IS SUSPECT IN SLOW PROGRESS OF EARTH-CLIMATE SCIENCES

Many ad hoc flow models for the upper mantle have been created to make sense of observed geomorphology, bathymetry, gravity, geoid field, and melt compositions. These models include plume upwelling and swell formation at hotspots, small-scale convection beneath plates, mantle flow and melt migration beneath moving spreading centers, convective overturn above subducting plates, asthenosphere flow associated with propagating rifts, downwelling beneath the AAD, return flow from trenches to ridges, and flow around subducting slabs during trench rollback. These models are considered refinements of plate theory in the three decades since the plate tectonic revolution and are discussed by principal investigators of mantle dynamics on the web-page of the ***Ocean Mantle Dynamics (OMD) Initiative.***

Hotspot eruptions of lava are distinct from those sampled at mid-ocean ridges or island arcs and are considered surface manifestations of buoyant plumes rising from the lower mantle by most investigators. A big question noted is "do distinct channels connect ridges to off-axis hotspots or is reactive porous flow more likely?" Another problem noted is "how are melts focused into narrow linear zones at ridges?" In order to address these questions, the larger issue of the validity of the basic working model of plate tectonics, which is virtually accepted without question by the majority of earth scientists, must be addressed. To do this, let's analyze what modern-day investigators have to say about mantle dynamics in light of a new theory.

POINT BY POINT REVIEW OF COMMENTS

In a recent review of one of my own paper submissions, reviewers objected to surge tectonics with the comment that "the inertial forces and Coriolis force must surely be negligible in the mantle." Dynamic viscosity is assumed to be on the order of 10^{18} to 10^{23} Poise (dyne-sec/cm^2). The term negligible has been used often in science to ignore what are considered small effects. When researchers consider climatic time intervals, the influence of microgravity on the atmosphere, and the sheer volume of material in a regional tectonic vortex, these forces may become apparent.

Difficulties in geodynamic modeling with plate tectonics are self-evident with comments by OMD principle investigators. Statements such as, "Previously, the geometry of plates had to be prescribed, i.e., inserted by hand, because the temperature-dependent, viscous creep representation of mantle rheology employed in the models did not permit the natural development of lithospheric plates. Instead, a rigid, globally continuous lid developed at the cold surface of the earth." What viscosity was used in these models? And what developed sounds possibly like the earth's original Archean shield with remnant magnetism found in modern day ocean basins now offered as the proof of plate tectonics (discussed by Meyerhoff and Meyerhoff, 1972b). Another objection raised by Meyerhoff in 1972 was that the term plate in "plate tectonics" is a misnomer. Plate means smooth flat thin material, whereas the earth is a sphere. Thus the rub, the theory might more aptly be called "bowl tectonics." Another comment implied the lack of a global application: "Small-scale convection in the asthenosphere of flow induced locally at plate boundaries is difficult to represent in global models, but have been successfully developed in regional models." Surge theory ideas are already being incorporated into newer modeling efforts as suggested by other comments such as, "New models are being constructed of two-phase flow that describe separate paths of melt and mantle matrix and the geochemical consequences of the separate paths of these two very different 'fluids.'" This seems to refer to geostreams and the counterflow generated in the asthenosphere as prescribed by surge theory. Then again, "Many models have been developed for plume-ridge interaction and particularly for flow away from Iceland in the asthenosphere along the Reykjanes Ridge" sounds like surge theory. Small excerpts say, "but there is a more efficient along axis distribution of melt in crustal magma chambers" and "melt transport into the lower crust may be highly 3-D and variable along axis." Along-axis flow is considered a high possibility. 3-D flow seems to be a surprise to plate theorists who tend to think in 2-D profile type convection patterns as evidence by statements like, "MELT investigators were able to demonstrate that mantle processes beneath the southern East Pacific Rise are distinctly 3-D." Serious concern is demonstrated by, "There is, however, no direct evidence for the existence of plume-like mantle flow beneath slow spreading ridges and serious questions have begun to emerge about this model." Really? This statement looks like the possible "death knell" for plate theory and is an isolated example of modern investigators finally starting to question the foundation of the model. Another statement, "Theoretical models will then be needed to use the seismological constraints to quantitatively examine the possible driving mechanism" implies driving mechanism models are needed. While the statement, "The problems of along-axis mantle flow, lateral variations in melting, and mantle mixing are intimately related" indicates along-axis flow is a problem for the current model. Comments abound showing the tentative nature of understanding encompassed by the plate model. For example, "Island arc magmas are produced through the interaction of volatiles from the slab with hot material in the mantle wedge, but the exact process and its geometry are uncertain" or "The pattern of mantle flow beneath fast spreading mid-ocean ridges and the magma plumbing system that transports melt from the upper mantle to crust is still very poorly understood."

SERIOUS QUESTIONS AND LAST STRAWS OF PLATE TECTONICS

Particularly pertinent to the link between tectonics and climate are comments by OMD investigators referring to the CPM discussed earlier: "There are intraplate, volcanic ridges on the Pacific Plate whose origin is not well understood." It goes on to say, "Their origin seems linked to equally enigmatic gravity lineations that are aligned in the direction of absolute plate motion," which refers to the CPM GEOSAT trends in Fig. 5. It continues with, "Although they have not been thoroughly investigated, it has been demonstrated that these ridges are not hotspot traces; they do not form in the near-ridge, spreading environment and they are not volcanic arcs in a subduction setting. Suggestions for their origin include small-scale convective rolls in the asthenosphere, lithospheric boundinage or stretching, and small plumes resembling mini-hotspots that originate in the upper mantle." The CPM does not fit into any previous ad hoc explanations, so some more explanations are construed. The investigators further state, "Whatever their origin, these ridges and gravity lineations provide one of the few clues to mantle processes in the vast intraplate region between plate creation at the spreading centers and subduction of the plates at trenches." This clue
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model of plate tectonics is sufficient. Is this good science?

Thirty to fifty hotspots are considered to be surface expressions of convection plumes arising from the deep mantle. At least 17 of these have documented chemical and physical influences on mid-ocean ridges. This leads to the previously noted big question, “do channels connect ridges to off-axis hotspots?” Surge

(6) Magnetic anomalies are generally near mid-ocean ridges, but ridges are not essential for the presence of magnetic anomalies.
(7) Magnetic time scales and reversal epochs are based on speculative assumptions and questionable extrapolations from sparse data.
(8) It is suspected that much of the drill hole data did not actually reach basement, but encountered basaltic underplating layers.

Thus, it is contended that sweeping conclusions based on speculations built upon misconceived assumptions and represented with flimsy data are the basis of proof for the plate tectonic model. A serious reevaluation of the evidence is in order. A genetic relationship between "linear" magnetic anomalies and Archean shields created during the early stages of earth's crustal formation is expected within the surge hypothesis.

CONCLUSIONS

waves in the oceans, or oceanic fronts. These fronts are pressure/temperature waves moving through their corresponding medium and in the earth are called surges, microgravity waves, or tectonic fronts (Leybourne, 1997).

The influence of gravitational teleconnection on atmospheric pressure may be factored into current global General Circulation Models by coupling geodynamic tectonic flow to ocean/atmosphere models based on principles of surge tectonics. Calculating a regional surge index for modeling longer-range climate patterns such as the ENSO may be possible. ENSO is controlled by the largest tectonic vortex structures on earth, the Banda vortex in the Indonesian Island Arc teleconnected across the Pacific Basin via the CPM to strong downwelling vortices along offsets on the EPR near Easter Island and Juan Fernandez microplates. Application of this concept in other areas, such as the North Pacific and the North Atlantic, provides the answers to questions such as: (1) What creates the large-scale changes in pressure (SLP) that cause a vacillation of meteorological patterns between zonal and meridional flow in the northern hemisphere? and (2) Why is zonal flow predominant in the southern hemisphere? East-west vs. north-south orientation of dominant vortices answers these questions. If geophysicists fail to explain the El Nino link to seismicity, there is little chance that the debate on "the human contribution to climate change" will ever be clearly resolved. Dedicating research funds allocated to global warming issues can be justified based on Walker's observations alone, and research can be implemented by the Ridge Inter-Disciplinary Global Experiments (RIDGE) and Ocean Mantle Dynamics (OMD) science plans. These are National Science Foundation initiatives that foster interdisciplinary scientific study of mid-ocean ridge processes. The possibility that tectonic phenomena may modulate weather patterns when gravitational potential energy is released or stored in ocean/atmosphere coupled dynamics as pressure and temperature changes should be investigated.

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B. A. Leybourne is an employee of the Naval Oceanographic Office. However, the opinions and assertions contained herein are those of the author, and are not to be considered as official statements of the U.S. Department of the Navy.

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