ARCHAEAN TO RECENT GEOLOGICAL MODELS OF THE EARTH

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Every corporate leader or executive involved in mineral or petroleum-based exploration and exploitation knows that they must be mindful of the need to continue exploring in order to remain both competitive and solvent in their respective industries. Geoscientists involved in the gathering and comprehension of geoscientific data about the Earth may also need to know how their valued find or research project relates globally over time. And similarly, interested persons need to feed their curiosity about the ancient Earth in order to understand more about what we are told in the social media.

In this respect, how often have you had access to detailed geological and geographical reconstructions of the ancient supercontinents? In particular, reconstructions that tell you exactly where your mineral or petroleum-based commodity was in relation to the global distribution of other like-commodities? Or similarly, reconstructions that show you precisely where your valued fossil find or research project was in relation to other finds or projects throughout Earth history, and what did Gondwana, for instance, really look like? All good questions just begging for answers as to why, after over 50 years of conventional palaeomagnetic-based crustal modelling, the geosciences still do not have access to meaningful reconstructions of the ancient Earth?

From my own past experience as a professional exploration and mining geologist the multitude of ill-defined schematic sketches of ancient supercontinental assemblages currently available are just not good enough to be of any use for modern geoscientific study or, in particular, as a basis for industrial and scientific application.

In contrast to conventional apparent-polar-wander based reconstructions of past supercontinental assemblages, modern global geological mapping of the oceans and continents is used exclusively in this introductory paper to recreate and model the entire 4,000 million years of Earth's known geological history. Spherical small Earth models constructed represent accurate reconstructions of precise continental and seafloor crustal plate assemblages extending from the early-Archaean to 5 million years into the future. This global geological mapping has only been available since 1990, well after conventional palaeomagnetics was first established, and its use represents a unique means to accurately constrain and reconstruct past geological plate assemblages independently of conventional palaeomagnetic apparent-polar-wander constraints.

The outcomes of this global geological modelling study are that:

- Formation of the ancient supercontinents and breakup to form the modern continents as well as sympathetic opening of each of the modern oceans is predictive, progressive, and evolutionary.
- All diametrically opposed ancient magnetic north and south poles are precisely located.
- Established poles and equator coincide fully with observed climate zonation and plant and animal species development.
- Coastal geography defines the presence of more restricted continental Panthalassa, Iapetus, and Tethys Seas, which represent precursors to the modern Pacific and Atlantic Oceans and emergent Eurasian continents respectively.
- Plant and animal species evolution is intimately related to supercontinental development, the distribution of ancient continental seas, and changes to climate zonation.
- Extinction events are primarily related to a number of drastic and prolonged changes to sea-levels.

- The spatial and temporal distribution of metals across adjoining continents and crustal regimes enables mineral search and genetic relationships to be extended beyond their known type localities.
- The presence of fossil fuels highlights the global interrelationships of resources coinciding with the distribution of a network of Palaeozoic continental seas and low-lying terrestrial environments.

The benefits of using modern global geological mapping to constrain plate assemblage for the entire history of the Earth are considered immeasurable. The application of these geological and geographical reconstructions to the geosciences is further considered to be limited only by your imagination. Each of the small Earth reconstructions presented here are uniquely relevant to science and industry by providing models that are accurate enough to know precisely where your particular research project, mineral discovery, climate change indicator, field project, fossil or mineral find was on the ancient Earth at any moment in time.

In the modelling study introduced here heavy reliance is placed on the published *Geological Map of the World* map (CMGW & UNESCO, 1990) (Figure 1) to constrain assemblage of both the oceanic and continental plates back in time. In order to achieve this aim, all mathematical-based preconceptions about Earth surface areas are simply ignored in order to both measure the ancient surface area of the Earth and establish a formula to determine an ancient Earth radius at any moment in time. This bedrock mapping and measured surface area data are then used to accurately constrain plate assemblages on small Earth geological models of the ancient Earth extending from the Archaean, some 4,000 million years ago, to the present-day plus one model extended to 5 million years into the future.

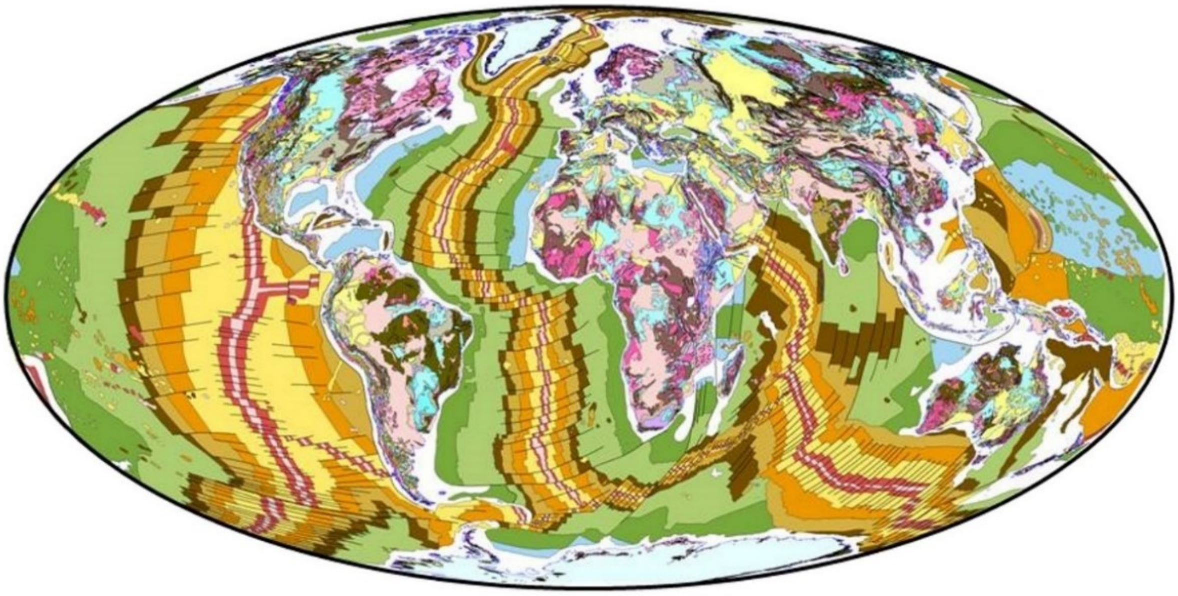

Figure 1 Geological Map of the World (CMGW & UNESCO, 1990) showing time-based bedrock geology reproduced in Mollweide projection.

The seafloor mapping shown on the Geological Map of the World was initially used to constrain the location and assemblage of all seafloor crustal plates on smaller radius Earth models (Figure 2). Modelling the seafloor crustal plates on small Earth models consistently show that all plates assemble back in time with a single unique fit, with all plates assembling with a high degree of precision along each of the mid-ocean-ridge spreading zones. This contrasts strongly with the multitude of poorly constrained plate-fit options and ill-defined schematic supercontinental assemblages proposed by conventional palaeomagnetics studies.

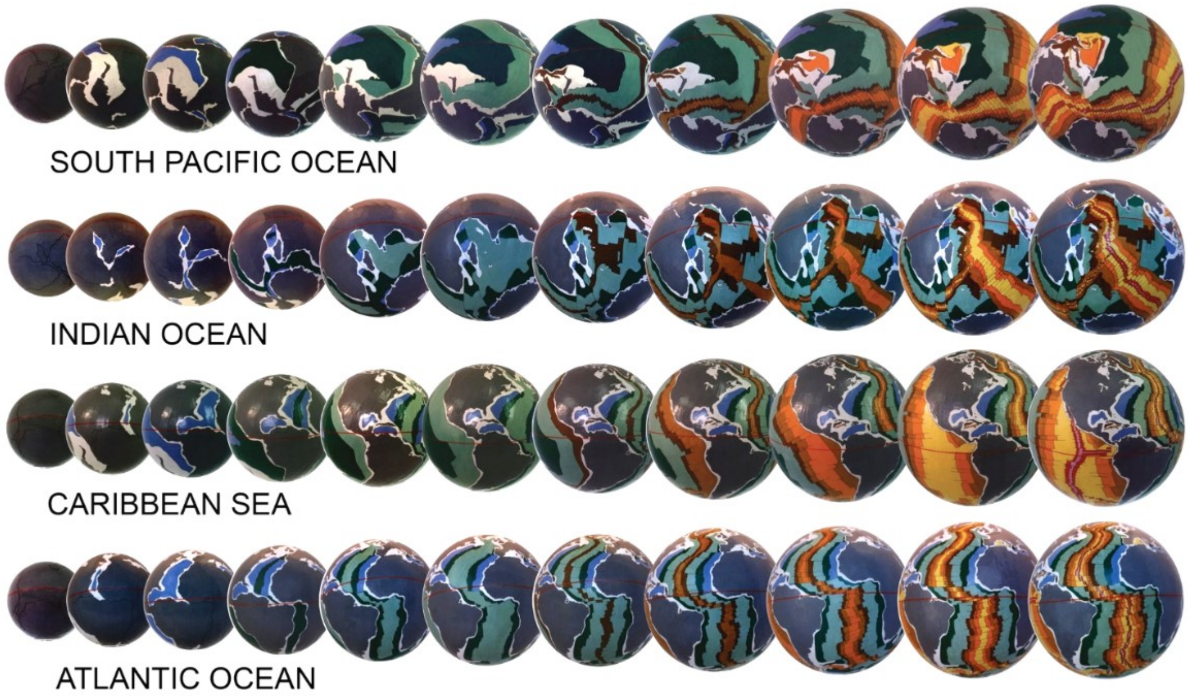

Figure 2 Spherical small Earth models of the Jurassic to present-day increasing radius Earth. Each small Earth model demonstrates that the seafloor crustal plate assemblage coincides fully with seafloor spreading and geological data and accords with the derived ancient Earth radii.

Quantification of small Earth models back to the early-Archaean requires an extension of the fundamental cumulative seafloor crustal premise to include continental crusts. Continental crust is reconstructed on pre-Triassic small Earth models by considering the primary crustal elements cratons, orogens, and basins. In order to construct small Earth models, further consideration is given to an increase in Earth surface area occurring as a result of crustal stretching and extension within an established network of continental sedimentary basins.

Moving back in time, this crustal extension is progressively restored to a pre-extension, pre-stretching, or pre-rift configuration by simply removing young sedimentary and intruded magmatic rocks and reducing the surface areas of each of the sedimentary basins in turn, consistent with the empirical data shown on the Geological Map of the World (Figure 1). During this process, the spacial integrity of all existing ancient cratons and orogens is retained until restoration to a pre-orogenic configuration is required. By removing all basin sediments and magmatic rocks, as well as progressively reducing the surface areas of the sedimentary basins in turn, an ancient primordial small Earth is assembled during the early-Archaean (Figure 3). During the early-Archaean this primordial Earth comprised an assemblage of the most ancient Archaean cratons and basement rocks existing on Earth today; all other rocks, minerals, and elements are simply returned to their places of origin.

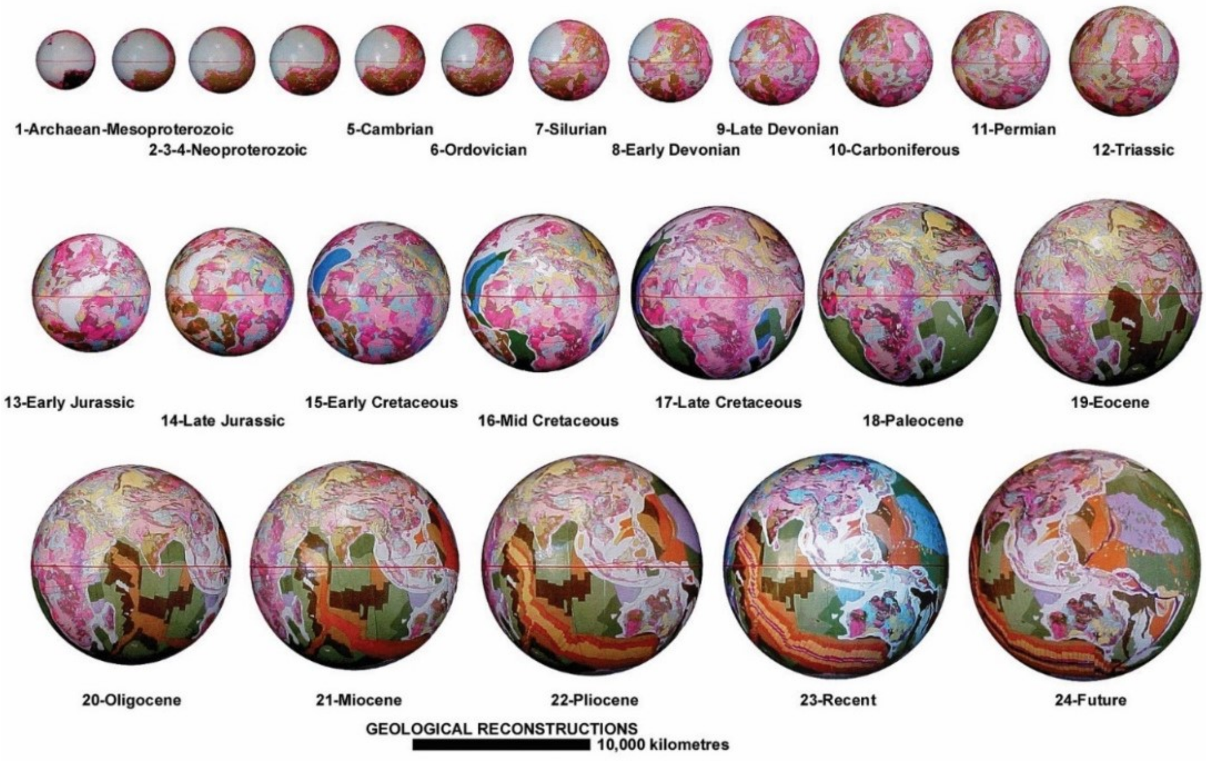

Figure 3 Spherical Archaean to future small Earth geological models. Models show relative increase in Earth radii over time showing both continental and seafloor geology. Models range in age from the early-Archaean to present-day, plus one model projected 5 million years into the future.

Applying this small Earth modelling study to palaeomagnetics shows that when the mathematically imposed constant surface area and constant Earth radius premises are removed from palaeomagnetic observations, these same observations demonstrate that the palaeopole data (International Palaeomagnetic Database, McElhinny & Lock, 1996) is consistent with an increasing radius Earth. The application of palaeomagnetics to small Earth models shows that all ancient magnetic poles cluster as unique diametrically opposed north and south poles and similarly, plotted palaeolatitude data (International Global Palaeomagnetic Database, Pisarevsky, 2004) coincide with and quantify predicted climate zones on each small Earth model constructed. Additional geographical and biogeographical information aptly quantify the location of these ancient magnetic poles, equators, and climate zones as determined from unconstrained palaeomagnetic pole and latitudinal data.

When published coastal geography is plotted on each of the small Earth models it is shown that large, conventional, Panthalassa, Iapetus, and Tethys Oceans are not required on a smaller radius Earth. Instead, this same coastal geography defines the presence of a more restricted network of continental Panthalassa, Iapetus, and Tethys Seas, which represent precursors to the modern Pacific and Atlantic Oceans and emergent Eurasian continents respectively. From this coastal geography the emergent land surfaces on each small Earth model is then shown to define the position and outline of the ancient Rodinia, Gondwana, and Pangaea supercontinents and sub-continents. This coastal geography demonstrates an evolutionary progression and development of each of the ancient seas and supercontinents throughout Earth history which is shown to be intimately related to changes in sea-level, changes to the outlines of continental sedimentary basins, changes incurred during crustal mobility, and changes to sea-levels once the modern oceans opened during a late-Permian breakup of Pangaea.

The timing and development of these ancient continental seas and supercontinents, along with formation of the modern continents and oceans, is shown to be the prime cause for evolution of all life forms on

Earth. The network of ancient continental seas, in particular, provided an ideal setting for the primitive Precambrian microbe's effectiveness as nurseries of evolution and to markedly drive subsequent evolutionary change in all life forms. On each of the small Earth models, it is shown that warm sea waters existing during much of the Palaeozoic extended from equatorial regions through to the North Polar Region allowing newly evolved species to readily colonise and populate throughout each of the interconnected ancient Tethys, Iapetus, and Panthalassa seaways. This distribution of warm seas also limited the presence of a polar ice cap in the North Polar Region and restricted presence to the exposed Gondwanan South Polar Region throughout much of this time.

On an increasing radius Earth the small Earth modelling studies show that, during early-Palaeozoic to present-day times there have been a number of drastic and prolonged changes to sea-levels which coincide precisely with known extinction events. On these models, major changes in sea-levels are shown to occur as a result of separation or merging of previous ancient continental seas, as well as onset of geosynclinal activity and orogenesis, breakup of the ancient supercontinents, opening of the modern oceans, and draining of the ancient continental seas. Depending on the severity of these events, it is considered that sea-level changes may have also adversely affected regional to global-scale climate, as well as ocean-water circulation patterns, species habitats, and the type and location of sedimentary deposition.

Modelling metallogenic data and mineralisation settings on small Earth models shows that the data and settings are essentially the same as those identified within conventional studies. The difference being that, on an increasing radius Earth, prior to the early-Triassic Period, all continental crusts were assembled together on a smaller radius supercontinental Earth. The small Earth assemblages then enable pre-Triassic metallogenic provinces from otherwise remote locations to be assembled together as unique, inter-related provinces on smaller radius Earth models. The assemblage of continents and crustal elements on small Earth models then provides a means to investigate the spatial and temporal distribution of metals across adjoining continents and crustal regimes. Recognition and understanding of past metal distributions on the present-day Earth then potentially enables mineral search and genetic relationships to be extended beyond their known type localities.

Modelling the distribution of all fossil fuels on small Earth models highlights the global interrelationships of resources coinciding with the distribution of a network of Palaeozoic continental seas and low-lying terrestrial environments. The transition from deposition of oil and gas shale to coal to petroleum and natural gas is found to be consistent with the various periods of maximum and minimum sea level changes occurring during periods of marine transgression and regression, in particular after regression of the continental seas during the Palaeozoic time periods leading to crustal breakup and opening of the modern oceans during the late-Permian.

The outcomes of this research demonstrates that the often highly emotive, albeit very outdated, past rejection of this tectonic concept is irrelevant to the needs of industry. By abandoning palaeomagnetics and using geology to constrain past plate assemblages of the ancient Earth it is possible to recreate and model the entire 4,000 million years of Earth's known geological history. You therefore have the right to access this new technology and all that flows from rejecting old established concepts in order to remain innovative and competitive in your chosen field of work, study, or interest. By simply reconsidering our long established physical understanding of the Earth, the successful integration of modern global geodata into the non-conventional tectonic perspective presented here constitutes a paradigm shift in geoscientific understanding of the ancient Earth.

For further queries, comments, or requests for additional coloured PDF papers of modelling studies from each of the geosciences considered in this paper please contact the author at: james.maxlow@bigpond.com You are also invited to view an extensive range of interactive geodata modelling studies from the fields of geology, geography, climate, biogeography, palaeomagnetics, metallogeny, and fossil fuels from my website at: www.expansiontectonics.com