GAVIN PUBLISHERS

Gavin Journal of Earth and Environmental Sciences

Kalaivanan R. J Earth Environ Sci 2017: J109.

DOI: 10.29011/JEES-109. 100009

Editorial

Paleo-climate studies using geochemical proxy From Marine Sediments

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Citation: Kalaivanan R (2017) Paleo-climate studies using geochemical proxy From Marine Sediments. J Earth Environ Sci 2017: J109. DOI: 10.29011/JEES-109. 100009

Received date: 14 March, 2017; **Accepted date:** 15 March, 2017; **Published date:** 20 March, 2017

Editorial

The science of past or ancient climates is known as "Paleoclimatology (also known as palaeo climatology"). Since it is not possible to go back in time to see what climates were like, scientists use imprints created during past climate, known as proxies, to interpret paleoclimate. Climate 'proxies' are sources of climate information from natural archives such as tree rings, ice cores, corals, lake and ocean sediments, tree pollen, or human archives such as historical records or diaries, which can be used to estimate climate conditions prior to the modern period (e.g. mid-19th century to date) during which widespread instrumental measurements are available. Proxy indicators typically must be calibrated against modern instrumental information to yield a quantitative reconstruction of past climate.

Marine sediments, especially along continental margins, are known to be one of the major archives for paleo environmental signals. Among others, geochemical as well as magnetic sedimentary proxies have often been used for pale oceanographic and Paleo climatic reconstructions (e.g. Muller and Suess, 1979; Thompson et al.,1980; Boyle and Keignwin, 182; Kent, 1982; Canfield and Berner, 1987; von Dobeneck and Schmieder, 1999; Frederichs et al.,1999; Reitz et al.,2004). Such records are essential for knowing about the climatic variability on a range of time scales, for the Holocene as well as glacial-interglacial intervals. The recovery of such core sediments of Holocene period has provided an opportunity to construct very high resolution records of climatic and oceanographic variability during the transition between glacial and modern conditions, and to study the relationship between water column productions, sediment supply and bottom water ventilation in a coastal basin. Bottom water oxygen levels in coastal basins respond not only to the rate of renewal of the deep water, but also to the settling flux of organic carbon through the water column.

The utility of geochemical proxies requires chemical analysis of geological samples. Since there is no means of directly measuring past climates and environments, proxy indicators are employed as indirect measures of the main processes. Information for environmental reconstruction comes from both organic and inorganic sources, even though organic matter (OM) typically constitutes a minor fraction of sediments. These proxies may reveal details about paleotemperature, phytoplankton community structure, vegetation history, dust provenance, nutrient cycles and availability, ocean circulation and paleoredox conditions.

Assessing paleo climate variability using the geological record necessarily depends on the development and reliability of climate proxies (Wefer et al.,1999). Marine sediments are composed of both biogenic and terrigenous materials. Paleoceanographers widely use both the type of sediments. The biogenic component includes the remains of surface dwelling planktic and bottom dwelling benthic organisms, which provide a record of past climate and oceanic circulation in terms of surface water temperature and salinity, dissolved oxygen in deep water, nutrient or trace element concentrations etc. Terrigenous deposits are detrital material derived from the erosion of the land masses surrounding the ocean basins and their mineral composition in sediments varies and reflects the provenance and weathering process (Bradley, 1999).

Sediment Geochemistry as Paleoclimate Proxy

Sediments hold important clues on the past geology and climate of depositional basins. Hence it is a challenge to explore for the past climatic signature in sediment archives to understand the future climate changes. Sediment geochemistry along with other proxies of climate change has become very useful in tracing the past climatic excursions. The mineralogy and chemical composition of deep sea sediments have been used to constrain the provenance of Aeolian sediments and signatures of chemical weathering linked to climate.

Stable Isotopes

Are based on the ratio between different isotopes of an element. The ratios are usually standardized by a reference value and named after the heavier isotope. The ratio between 18O and 16O, for example, is represented by δ18O. Isotope readings are retrieved mainly from foraminifer's skeletons (tests), organic matter or other sources. The amount of 18O incorporated by organisms like foraminifera and corals increases as temperature decreases. Continental ice is relatively depleted in 18O compared to sea water. This makes δ18O a proxy for both temperature and the extent of continental ice sheets. Boron is used as pH proxy. Productivity, nutrient concentration and past circulation can be reconstructed from δ15N and δ13C. Together with microfossil assemblages, δ18O and δ13C are the paleo - oceanographic proxies with most widespread use.

Radiogenic Isotopes

The different solubility's of uranium and two products of its naturally occuring decay, thorium(Th) and protactinium (Pa) can be used to estimate the rate of deep water flow and the flux of particles from the water column to the sediments. This flux can also be used as a productivity estimate. 14C preserved in organic matter is used to estimate the age difference between near surface and deep water and hence, ventilation rates.

Elements

The concentration and ratios of certain elements in the sediments, m to calcium (Mg/Ca) in biorganic material, tests and corals are also used as proxies. The ratios of strontium to calcium (Sr/Ca) and magnesiuologically precipitated marine carbonates are temperature dependent. The cadmium to calcium (Cd/Ca) ratio is used for nutrient reconstructions. Barium concentration and Ba/Ca ratio are proxies for productivity and alkalinity respectively.

Sediment logy

Grain size distribution can provide qualitative information about bottom current speeds and act as an indicator of ice rafted debris. Information about past tides can be inferred from layered sediments called rhythmites. The mineralogy of the sediments can be used to establish source areas and direction of transport for both water and wind borne sediments.

Conclusion

The geologic record truly serves as a record set in stone of valuable information concerning climate change and the relationships between the Earth's physical systems and the life that occupies the planet. As climates change, they exact forces on the landscape that change the arrangement of the Earth's surface features, but they also alter the Earth's surface and subsurface features in chemical ways. Although these alterations may not always be obvious, they also tell a detailed story about the climates of the ancient past. Because of this, it is possible to determine seasonal variations in temperature and precipitation, changes in the movement of ocean currents, and fluctuations in the carbon cycle going back hundreds of millions of years by analysing geologic and geochemical proxy data. In summary, it is obvious that more ground truthing studies are required in this rapidly emerging field of chemical oceanography/paleoceanography.