

Mass independent fractionations and their occurrences in nature

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In the early theories and experiments of stable isotope geochemistry, it was firmly established that the mass difference between stable isotopes was the key parameter controlling their distribution among species and phases, resulting in a strong correlation between isotopic ratios of an element owning more than 2 stable isotopes. Because the only deviations from the mass law found on Earth were measured on cosmogenic materials, it was admitted that all isotopic substances on Earth should scale with the terrestrial mass dependent fractionation law.

The discovery of a mass-independent isotope fractionation process (MIF) in the laboratory, later confirmed in the Earth's atmosphere, has changed for ever the way stable isotope ratios are measured and interpreted. Because the atmosphere is in perpetual interaction with the surface, isotopic anomalies are now found on ground minerals of atmospheric origin. Thus a wealth of information about the state of the atmosphere can be gained by studying isotopic anomalies fossilized in sediments or glaciological archives. Oxygen and sulphur, the only light elements possessing more than two stable isotopes and being at the same time intensively exchanged between the atmosphere and other compartments of the Earth, are the cornerstone of this research.

During this keynote talk, I will first present the first principles behind the mass dependent and independent fractionation theory. Next, I will show how isotopic anomalies record the chemical state of the atmosphere and thus how they can be used to reconstruct the paleoenvironment, going from climate studies to catastrophic events, moving from the Archean to present times.

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