# Pleochroism in calcic labradorite from Oregon: Effects from size and orientation of nano- and micro-precipitates of copper and pyroxene

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The cause of pleochroism in calcic labradorite from the Dust Devil Mine in Lake County, Oregon, commonly known as sunstone, is described in detail. The size and orientation of copper and Fe-bearing enstatite inclusions are responsible for this phenomenon. Copper colloids that occur in thin, disc-like micro-arrays cause transparent red and green colors that are different from the well known “schiller” or iridescence commonly seen in labradorite from this locality. The “schiller” described in previous works, is due to copper disks that are approximately 30 µm wide, less than 1 µm thick, and oriented on (010) (common) and/or (001) (less common) [1, 2]. The red color is due to reflections off small, less than 2 µm, sized colloids that form parallel (001). The green color is expressed when the same crystal is turned to (100), the thin flakes are normal to the line of sight and appear as rods, which reflect green. On (010) all three phenomena are visible because of the perpendicular crossing of the other axes, which yields some large copper flakes along with cross sections and dots. Under SEM, Fe-bearing enstatite has also been observed as inclusions in calcic labradorite, sometimes in direct contact with copper. TEM work is still to be done to further explore the details of this phenomenon.

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[1] Nishida & Kimata (1992) *Japanese Magazine of Mineralogical & Petrological Sciences* **31**, 268-274. [2] Hofmeister & Rossman (1985) *Geology* **13**, 644-647.

# A multi-proxy perspective on isotope evolution of Phanerozoic seawater

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We present a compilation of published calcium ($\delta^{44}$Ca), carbon ($\delta^{13}$C), oxygen ($\delta^{18}$O), sulfur ($\delta^{34}$S), strontium ($^{87}$Sr/$^{86}$Sr) and neodymium ($\varepsilon_{Nd}$) isotope records of Phanerozoic seawater, as reconstructed from the analysis of marine skeletal carbonates and phosphates. These isotope trends were smoothed using the moving average method and subsequently analyzed by principal component analysis to identify patterns of inter-correlation among the isotope systems. The results of the analysis show that about 88% of variance in the Phanerozoic dataset can be explained by three components. The first component links $^{87}$Sr/$^{86}$Sr and $\varepsilon_{Nd}$ ($R^2$ = -0.66), the second accounts for a strong coupling between $\delta^{18}$O and $\delta^{44}$Ca ($R^2$ = 0.75), and the third anti-correlates $\delta^{13}$C and $\delta^{34}$S secular trends ($R^2$ = -0.76). The first component is related to tectonic processes, likely to changes in the mean isotope composition of continental riverine weathering flux as well as total dissolved flux and its effect on Sr and Nd isotope budgets of the oceans. As to the interpretation of the second component, we propose that the changing magnitude of hydrothermal flux, generated from the low-temperature (<350 °C) alteration of oceanic crust, could be the cause of positive loadings of $\delta^{18}$O and $\delta^{44}$Ca. The third component is believed to reflect the net effect of redox processes on sulfur and carbon isotope fractionation in marine environment.

[1] Keto L. & Jacobsen S. (1988) Nd isotopic variations of Phanerozoic paleoceans, *Earth Planet. Sci. Lett.* **90,** 395-410. [2] Veizer J. *et al.* (1990) $^{87}$Sr/$^{86}$Sr, $\delta^{13}$C & $\delta^{18}$O evolution of Phanerozoic seawater, *Chem. Geol.* **161,** 59-88. [3] Kampschulte A. & Strauss H. (2004) *Chem. Geol.* **204,** 255-286. [4] Farkaš J. *et al.* (2007) *Geochim. Cosmochim. Acta* **71,** 5117-5134.