Magnetic records of early planetary differentiation

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Several classes of meteorites formed during the first stages of planetary evolution may record the early history of differentiation and possibly even magnetic field generation in planetesimal cores. We have been conducting paleomagnetic analyses on angrites, among the oldest known pristine basaltic meteorites, and the CV carbonaceous chondrite Allende, traditionally thought to sample an undifferentiated body. We found that angrites record a past magnetic field of ~10 microteslas on the angrite parent body extending from 4564 to at least 4558 million years (Ma) ago. Allende, which acquired its magnetization over millions of years at least 10 Ma after accretion of the CV parent body, records fields of similar intensity. Because the angrite and Allende paleomagnetic records extend beyond the expected lifetime of the early circumstellar disk, these paleofields were probably generated internally on the parent bodies, possibly by early dynamos in rapidly formed metallic cores. In particular, the CV parent planetesimal may be a partially differentiated body with an unmelted, relic chondritic surface that was magnetized during metasomatism in the presence of an interior metallic core dynamo. Planetesimal core dynamos may have been widespread but short-lived phenomena in the early solar system.

P/Ca in planktonic foraminifera as a new proxy for marine PO_4: Results from the Cariaco Basin

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Recent work has shown evidence for a new seawater nutrient proxy in P/Ca ratios in corals [1, 2]. In foraminifera, early research suggested that phosphorus only exists in Fe- and Mn-rich coatings of foraminifera shells; not as a primary constituent of the shell matrix [3]. Here, we analyze the P/Ca ratios in shells of four species of planktonic foraminifera (*Orbulina universa, Globigerinoides sacculifer, Globigerinoides ruber,* and *Globorotalia menardii*) and their relationship to seawater PO_4, dissolved organic P (DOP), and total dissolved P (TDP) in the Cariaco Basin. The Cariaco Basin is characterized by intense seasonal upwelling, making it an ideal location to test if the P/Ca ratio of foraminiferal calcite reflects nutrient availability of surrounding waters. Samples are from bi-weekly sediment trap samples collected in the eastern Cariaco Basin (10° 30'N, 64° 40'W) during 2005–2007. Water column phosphorus profiles were collected monthly. Concentrations of P within the foraminiferal shells ranges from 0.177 - 3.799 and varies between species. P/Ca range from 0.208 – 0.962 in *O. universa,* 0.177 – 0.775 in *G. sacculifer,* 0.442 – 3.799 in *G. ruber,* and 0.264 - 1.706 in *G. menardii* with the highest values occuring in January during winter upwelling and in June – August during secondary upwelling. The P/Ca ratios in *O. universa* and in *G. ruber* are positively correlated with PO_4 ($r^2 = 0.40$, $p = 0.009$; $r^2 = 0.61$, $p = 0.023$ respectively). In contrast, P/Ca ratios in *G. sacculifer* and *G. menardii* are not. Furthermore, there are no significant correlation between the P/Ca ratios of any of the species and DOP and TDP, suggesting that the foraminifera only incorporate PO_4 into their shells during growth.

[1] Montagna *et al.* (2006) *Science* **312**, 1788-1791.
[2] LaVigne *et al.* (2008) *Geophys. Res. Lett.* **35**, L05604.
[3] Sherwood *et al.* (1987) *Geochim. Cosmochim. Acta* **51**, 1861-1866.