Stable isotope variations in a modern North Sea oyster shell reflect annual environmental changes

C.V. ULLMANN*, U. WIECHERT AND C. KORTE

Institut für Geologische Wissenschaften, Freie Universität Berlin, Malteserstr. 74-100, 12249 Berlin, Germany (*correspondence: c.v.ullmann@gmx.net)

$\delta^{18}O$ and $\delta^{13}C$ values of low-Mg-calcite fossils have been widely used to reconstruct paleoclimatic and paleoenvironmental conditions [1, 2]. The stable-isotope composition of modern *Crassostrea virginica* shells for example reflects both temperature and salinity variations [3], but these samples originate from an estuarine habitat with considerable annual changes in salinity. In the present study we have focused our attention on $\delta^{18}O$ and $\delta^{13}C$ values from a single specimen of the modern Pacific oyster *C. gigas* from a sub-tidal oyster bank in the List Basin east of Sylt Island (North Sea, Germany) where fully marine conditions occur all the year round. We sampled along a traverse in growth direction through the umbo of the shell and analyzed 181 samples for their $\delta^{18}O$ and $\delta^{13}C$. Oxygen-isotope values vary periodically between -2.5 and +1.3 ‰. We interpret these fluctuations, taking the natural seawater $\delta^{18}O$ changes into account, to reflect the annual seawater temperature variations of about 20°C that are reported for this region. These occur constantly over the four years of the oyster's life, indicating that shell build-up took place continuously from spring to autumn. These results are in contrast to earlier observations that some bivalves stop shell secretion in the summer months after reaching sexual maturity [4]. The $\delta^{18}O$ results further indicate that *C. gigas* grows from approximately March to November, in accordance with biological results [5]. The relatively high variability in oxygen-isotope ratios suggests that minimum temperatures for the onset of growth in *C. gigas* are near 6°C, not near 10°C as hitherto suspected for this and other *Crassostrea* species [6, 7]. The $\delta^{13}C$ values of the *C. gigas* shell show that a sudden 1 to 2 ‰ positive excursion to heavier values occurs in the spring secretions of any annual cycle. These trends may be caused by enhanced biological production in the seawater or by metabolic processes of the oyster.

[1] Veizer *et al.* (1999) *Chem. Geol.* **161**, 59–88. [2] Korte *et al.* (in press) *J. Geol. Soc.* [3] Surge *et al.* (2001) *Palaeogeogr. Palaeocl.* **172**, 283–296. [4] Williams *et al.* (1982) *Nature* **296**, 432–434. [5] Diederich *et al.* (2005) *Helgol. Mar. Res.* **59**, 97–106. [6] Kirby *et al.* (2000) *Palaios* **15**, 132–141. [7] Quayle (1988) *Can. B. Fish. Aquat. Sci.* **218**.

Differentiation of hydrous calc-alkaline magmas at mid to lower crustal levels: Experimental constraints

P. ULMER[1]* AND O. MÜNTENER[2]

[1]Department of Earth Sciences, ETH-Zurich, CH-8092 Zurich, Switzerland (peter.ulmer@erdw.ethz.ch)
[2]Institute of Mineralogy and Geochemistry, University of Lausanne, CH-1015 Lausanne, Switzerland

Formation and growth of juvenile arc crust from primary mantle-derived, hydrous, calc-alkaline magmas is a polybaric process. Compositions of magmas separating from mantle residues are modified through interaction with lithospheric mantle and lower crust and by crystallization-differentiation that drives them towards andesitic to dacitic liquids forming the major part of the middle and upper arc crust.

Here we summarize the results of equilibrium and fractional crystallization experiments targeted at the evolution of primary mantle-derived and derivative hydrous magmas under conditions prevailing at the base and in the lower part of a growing island arc crust (0.8-1.5 GPa). Employed primary picrobasaltic to high-Mg andesite starting materials are representative for mantle extraction depth varying between 90 and 40 km. We investigated the mutual phase relations of the principal phases olivine, cpx, opx, garnet, amphibole, plagioclase and spinel. At pressures exceeding 0.8 GPa (25km) between 45 and 70% of ultramafic, clinopyroxene and amphibole dominated cumulates are produced to obtain andesite to dacite compositions that are typical for more evolved island-arc magmas and rocks (tonalites) forming the upper part of the igneous system. Delayed plagioclase crystallization at the expense of early amphibole saturation shifs derivative liquids closer to the metaluminous / peraluminous limit or even within the peraluminous field with increasing pressure.

Trace element partitioning between the principal higher pressures phenocryst phases (cpx, opx, garnet, amphibole) and basaltic to dacitic liquids along the liquid line of descent has been determined at 0.8-1.5 GPa. We utilized these new partitioning data to model the trace element evolution of liquids experimentally produced by fractional crystallization at 1.0 GPa. We found that computed REE and trace element patterns reveal striking similarity with natural examples from plutonic complexes showing petrological evidence for high-pressure evolution (early amphibole, delayed plagioclase) expressed for example but steep REE patterns and high Sr/Y ratios commonly attributed to slab melt contributions and/or involvement of garnet in their genesis.