DSPMU UNIVERSITY, RANCHI.
DEPARTMENT OF GEOLOGY

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GEOCHEMICAL BEHAVIOUR OF ELEMENTS - SILICON

Most common form: Si^{4+}
Ionic radius: 0.26 A
Stable isotopes: 28 (92.23%), 29 (4.67%), 30 (3.10%)
Atomic weight: 28.086
Residence time in seawater: 20, 000 years

Silicon is, after oxygen and iron, the third most abundant element in the Earth. Although Si concentration in the core may reach several percent, this ubiquitous element is essentially lithophile and refractory. It is the most abundant cation of the silicates that form the mantle at shallow depth (olivine, pyroxene, plagioclase, garnet), at intermediate depth (ringwoodite, majorite), and in the deep mantle (perovskite). It also forms the major igneous minerals in the crust of both mafic igneous rocks (olivine, pyroxene, amphibole, plagioclase) and felsic igneous rocks (quartz, feldspars). Silicon is a major constituent of elastic sediments (quartz and clay minerals) and makes up a substantial fraction of metamorphic minerals.

At pressures corresponding to the surface, the crust. and the upper mantle, Si is tetrahedrally coordinated and occupies the center of a four oxygen tetrahedron. At very high pressure. Si can be accommodated in octahedral sites. Since melts from the mantle are systematically enriched in silicon with respect to the residue, this element may be classified as slightly incompatible. It forms stoic-hiometrically fixed minerals: the various forms of silica SiO_2 are stable at different pressures: quartz and amorphous silica are stable in the crust and the upper mantle, while coesite and stishovite are stable at increasingly higher pressures. A basalt typically contains 45-50 wt % SiO_2 and granitic melts >67 wt % SiO_2. Quartz is unstable in the presence of Mg-rich olivine. Silica solubility in hydrous fluids increases with temperature and with pH.
High-temperature fluids transport large quantities of SiO2 which, upon cooling, form the ubiquitous quartz veins seen in metamorphic basements. Warm diagenetic fluids carry silica. which precipitates in the upper sedimentary layers: this is the origin of the familiar flintstones that grow on any seed (fossil, pebble) occurring in limestones. When the replacement of the initial sediment is total. a siliceous rock known as chert is obtained.

As a result of the very low solubility of silica at ambient temperature, quartz is essentially left untouched by erosion and forms the familiar sands that, upon diagenetic cementation, become sandstones,. For the same reason, silica concentration in seawater is very low and , as a result of biological activity, the ocean is actually under saturated in silica. SiO_2 is used by both phytoplankton (diatoms) and zooplankton (radiolaria). Silica is therefore depleted in the upper layer of the oceans, while the falling debris redissolves at depth. Deep old waters are the most enriched in silica. Oceanic upwellings, such as the Atlantic Ocean off the coast of Morocco or the equatorial belt, bring up abundant sources of silica. Sediments from those area are rich in silica deposited by falling organisms. Other localities, with warm hydrothermal springs on the seafloor such as in the neighbourhood of ridges and other volcanic areas, are also rich in siliceous sediments. The older waters from the Southern Oceans being rich in silica, it is not surprising to see a substantial fraction of the seafloor of the southern hemisphere covered with diatom-rich oozes.