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G203 Lecture Notes

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Speculation that any early ocean may have repeatedly vaporized and recondensed.

Interior of earth 8000c or 14,000f

Heat drives plate tectonics

Temperature is also the reason for lithosphere/asthenosphere

Sources for internal heat of earth:

(Left over from formation)

1. Accretional heating – moving objects come together to form earth. Kinetic energy converted to heat.

2. Core formation (differentiation) – as dense material sinks and light material rises, gravitational potential energy converted to heat.

(Present at beginning and continuing today)

3. Solidification of core – FeNi metal liquid – solid reaction is exothermic (releases heat)

4. Decay of radioactive atoms (parent isotopes) releases heat.

Early atmosphere on earth:

Substantial melting of earth should have led to out gassing of mostly water vapor, carbon dioxide and smaller amounts of nitrogen and sulfur dioxide. Atmosphere probably much more massive than today, with larger greenhouse effect. (Essentially no free oxygen)

Most of the out gassed water vapor (probably) condensed to form the earth's early oceans which were likely more acidic than today from the reaction with atmosphere – inhibited formation of carbonate rocks.

We can estimate how much atmosphere has been lost to space by looking at the difference between light and heavy isotopes of nitrogen.

Venus and mars have the atmospheric composition we expect for a terrestrial planet (ignoring water).

Earth was the right size and in the right location to have liquid water!

Hadean Crust: Expect mostly oceanic crust of Komatiite or Basalt (mostly underwater) with (possibly) some hot spot volcanoes above the waves (all of this has since been destroyed).

Oldest rock sample on earth – 3.96 b.y. old Acasta Gneiss

Also a few zircons aged 4-4.4 b.y. old

Image of Acasta Gneiss located at: http://paleobiology.si.edu/geotime/main/images/ev_arc_03.gif

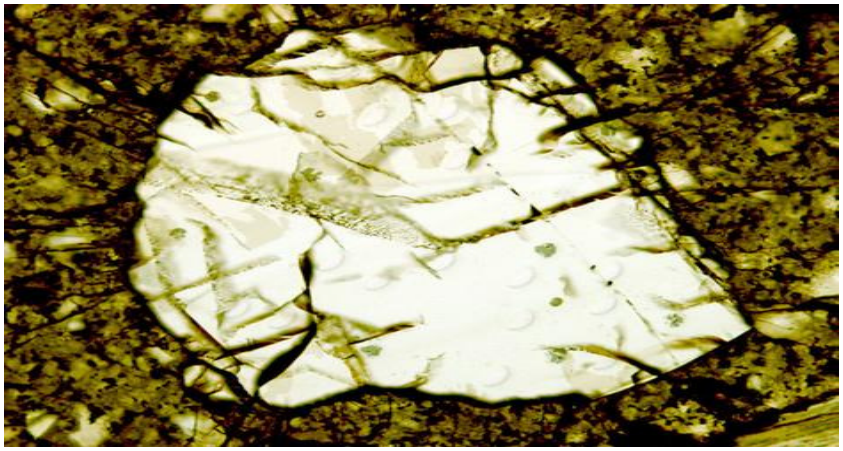

Image of a zircon grain found at:
http://www.smh.com.au/ffximage/2009/01/26/zircon_wideweb__470x378,0.jpg

Zircons and Acasta Gneiss derived from granitoid precursors.

Granitoid – (granite-like) (felsic to intermediate)

Igneous rocks or their metamorphic equivalent

The presence of granitoid rocks in the Hadean implies that the earth already had some continental-type crust.

How do you form continental crust?

Unclear

Today we get felsic rocks by remelting continental crust.

Possibly produced by igneous processes such as fractional crystallization and partial melting.

Another possibility:

Weather ultramafic/mafic rocks that are above sea level and melt weathering products.

Currently under debate:

Until recently, textbooks say that the creation of the continental crust takes place in Archean, not Hadean.

Whatever crust was above water was devoid of any life!

Summary

-Accretion (formation of earth from smaller objects) – chrondritic in compostition

-Differentiation (formation of core/mantle/crust).

-formation of atmosphere and ocean

-early intense bombardment

Archean

(3.8 – 2.5 b.y. old)

-dominated by granitoid-greenstone rocks

-growth of continental crust

-oldest paleosol

-oldest evidence of life

-banded iron formations appear

-at very end of Archean (oldest glacial deposits)

Archean granitoids are mostly granalitic gneisses that represent highly metamorphosed granites.

Archean granitoids are felsic

-continental crust

-requires at least two episodes of melting

Archean granitoids are heavily metamorphosed

-rocks altered at great depths

-reached surface by uplift/erosion