Workshop Without Walls: Upstairs Downstairs

Breakout Group 3 Note-taking

Room 783

Burial without plate tectonic regime? Do what level do we need to get stuff back into the mantle? Need to recycle volatiles, carbon + phosphorous

carbonate rocks, sequestering? timescale questions, need to be stable for 10,000 yrs vs. 1 million or a billion years?

how fast does carbon build up without recycling? most is in continents, changes timescales?

Observables: number of these for plate tectonics is rather low, we could measure the fraction of a planet's surface covered by continent vs. ocean, but does that tell us what we need to know? can we have that without plate tectonics? (hot spots?)
potentially: for a planet with explosive eruptions, sulfate aerosols in atmosphere. explosive eruptions at subductive boundaries, difficult to get those eruptions with hot spot volcanism (would need to observe a planet relatively frequently over long time to see transient signal)

biosignature could be "kinetic" and not something we think about with current mission designs

what could another way be to create clumps of land masses (e.g. landmasses on mars if there was liquid water ocean? no plate tectonics)

consensus that we need a "geologically active" planet, vs. "plate tectonics"
from habitability standpoint, recycling seems to be the most important, how did we sustain in early Archaea?

maintain habitable Earth but change it fundamentally, supercontinents can play fundamental role in sequestering carbon, changing atmosphere, etc. *different degrees of habitability
*long term "stable" world may not be good for evolutionary diversity, complex forms of life

Rhodinia on Earth → interesting experiment
supercontinents not whole story but could be large part of the story
build up of carbonates could change over time (function of living organisms around) even within the overall cycle of the supercontinent formation/breakup

albedo contrast → can you really be sure of difference between water and land? but oceans can be bluer and land can be "redder" (our bias because of our oxic world)

how do you rule out cloud contribution to albedo? do need long-time observation on target

*need good spectral contrast to distinguish ocean vs. continent (DIRECT IMAGING)
maybe transit spectroscopy could give us information about aerosols in atmosphere
timescales over which eruptions keep aerosols in the atmosphere? would need to actually be able to catch that in observing

seafloor weathering? could be very important for water worlds, early Earth
*maybe not important in today's carbon/climate cycle, but could have been very important with 20 degree increase in temperature of deep waters

*if you can weather sea floor, plate tectonics would not be as important
how well-constrained is pressure-dependence for seafloor weathering rate? soluble of calcium carbonate is extremely temperature dependent

We want to also know how old the planet is… estimates from stellar age (at least give us differences between Hadean vs slightly aged planet)

getting more P out of felsic rocks → makes sense that granite has less than basaltic because of weathering processes. do we have evidence of granite composition elsewhere in the solar system?
we can get estimates of oxygen content of atmosphere based on color of rocks

*more evidence is leading us towards a more habitable Hadean, and plate tectonics was probably not operating that early on, at least to the degree that it happens today

to have zircons (in which we have small amount of evidence for carbon/organics/life), differentiation must be going on, but that could potentially happen without subduction processes.

*rapid imaging with camera, as hand moves tiny amounts, pixel gets different light from different parts of frame → mulit-pixel imaging implement for direct imaging of exoplanets? but an actual planet would perhaps take up less than 1 pixel, which wouldn't work.

for astronomical observations it's difficult to get past the diffraction limit, but single-pixel studies should not de-motivate us

See this paper on map of brown dwarf:
http://www.nature.com/nature/journal/v505/n7485/full/nature12955.html

finding out whether planet is geologically active is inherently difficult problem (even with Venus it is really hard…) what are other tectonic signatures that we could look at? fresh lava glowing in infrared? magnetic fields speak to inductive/heated interior

how to even measure magnetic fields? measuring burst of auroras in the visible? radio measurements from host star? (new paper) radio emission of giant planets corresponding to magnetic field, but might be hard to differentiate where magnetic field is coming from if you have multiple planets in the system.

radio searches for exoplanet aurora relies on electron cyclotron, upper frequency cut off is set by where cyclotron frequency matches magnetic field strength (?)
lower frequencies would be harder to detect at the ground (washed out by ionosphere)

*but, mercury for example has a magnetic field, so what does it really tell us? would need to perhaps correlate with rotational/orbital period and whether in the habitable zone? wouldn't necessarily mean it's generating in the same way that the Earth generates dynamo

if you rely on mass, radius and composition of outer atmosphere, knowing whether there is a dynamo/magnetic field is still an important piece of information → could we get interior model information (like moment of inertia) working with multiple planet systems physics?

interacting pairs of planets, orbital eccentricities can...