The Moons of Jupiter, Europa, and Potential Life

Part A: Jovian moons vs. Rocky planets

Earlier this semester we discussed why Earth is so geologically and tectonically active — it still has a lot of internal heat (gravitational energy leftover from formation). Recall that when we discussed other rocky objects (such as the Moon, Mars, or Mercury) they are not tectonically active because they are much smaller than the Earth, and thus have less internal heat.

1. Given this information, would you expect any of the relatively small Jovian moons to have much geologic activity (internal heat)? Why?

2. How did Earth get its atmosphere? Would you expect any Jovian moons to have an atmosphere?

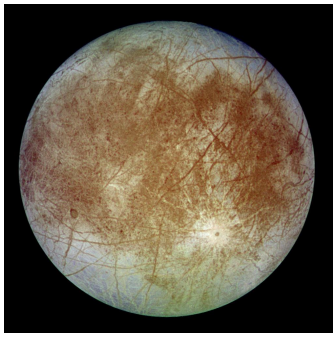
3. Earth's magnetic field, which is crucial to the survival of its atmosphere, is generated by an internal moving, liquid conductive layer (metallic core). Mars no longer has a magnetic field, why?

4. Would you expect any of the Jovian moons to have a magnetic field? Why or why not? How would this affect a hypothetical moon's atmosphere?

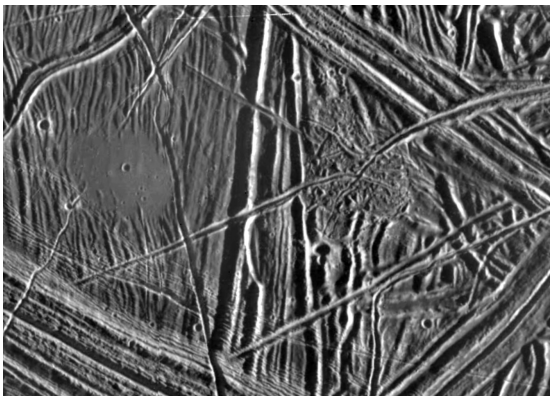
5. After considering **only** the above, what would you expect the chances are that the surface of the Jovian moons are habitable? What can you say about the subsurface?

Part B: Europa's subsurface ocean — How do we know?

We're now going to walk through the pieces of evidence we have that make us almost 100% positive there is an ocean under the surface of Europa.



1. Look at the picture of one of Europa's hemispheres to the right. How does the surface appear? What does it tell you about the age of Europa's surface?



2. Look at the close up picture of Europa's surface to the right. What kinds of features do you see? Do they remind you of anything on Earth? What could be causing them?

3. Spectroscopy of Europa's surface indicates that the red color is likely due to salt minerals being plentiful on the surface. Where could this salt be coming from and how could it be replenished on Europa's surface?

4. When *Galileo* was orbiting Jupiter, it detected a weak magnetic field generated by Europa. Given Europa's structure and internal heat, is the magnetic field likely to be caused as Earth's is (liquid metallic core)? What other material inside Europa could be generating the magnetic field?

Part C: Life under Europa's surface

Let's assume we're right, and there is indeed an ocean beneath the surface of Europa. In this case, the first requirement for life — a liquid medium — is present on Europa! Let's discuss the other requirements and their implications.

1. Most of Earth's life derives its energy in some way (directly through photosynthesis or indirectly through food) from sunlight, even much of the life at the bottom of the ocean. Is this a possible source of energy for life on Europa? What other sources of energy could there be (think Earth life that doesn't need the Sun)?

2. Possible energy sources for life in Europa's ocean would provide at least ten thousand times less energy as photosynthesis on Earth generates. What does this mean for the kind of life you would expect in Europa's oceans? Will it be like life in Earth's oceans?

3. Europa's ocean would also need material with which to form organic molecules and building blocks of life. If you were to test water from Europa, what materials would you look for to determine whether or not the material for life to form exists there?

4. When we discussed life on Mars, we discussed panspermia — life could have been transported between Earth and Mars, and life on both worlds would share a common origin. Do you think panspermia would be possible between Earth/Mars and Europa? If life formed independently on Europa, what does that tell you about prevalence of life in the universe?