Hi this is Steve Nerlich from Cheap Astronomy www.cheapastro.com and this is *No place like home.*

It's been suggested that even a galaxy only has certain areas, or habitable zones, where life as we know it might get started. For the Milky Way, this region starts from about 25,000 light years out from the galactic core – as any closer in, the galactic medium becomes increasingly dominated by high energy gamma and x-ray radiation, reducing the likelihood of any complex organic molecules being able to form.

There is probably an outer limit too, since it's unlikely there would be enough complex raw materials around for life to get started outside dense areas of star formation – or more specifically areas of star destruction – where supernovas spread a rich mixture of heavier atoms produced from the fusion of simple light atoms such as hydrogen and helium.

This may rule out elliptical galaxies as potential cradles of life – since they are characterised by ageing stars unlikely to be supernova candidates and they have virtually no intervening stellar gas to enable to new stars to form. However, if it turns out these galaxies had a wilder youth, we might need to re-think this rule.

Anyway, we can state with confidence that life is able form in a spiral galaxy and to form in that region we currently consider a galactic habitable zone – because here we are. It's a circular argument that may be broken the first time we do come across another life data point, but until then it's these kind of considerations that guide where we point our SETI telescopes.

Earth is thought of formed about 4.57 billion years ago in what we parochially call the habitable zone of the solar system – although first there was Earth Mark 1, which got hit by a Mars-size object to form a much denser Earth Mark 2 – accompanied by a new Moon made of impact debris. The Moon is thought to have begun orbiting the remodelled Earth at about 4.53 billion years ago.

The earliest rocks we can find on Earth, in Greenland and Australia, date to about 3.8 million years ago. So what went on between 4.5 and 3.8 billion years ago remains a matter of some conjecture.

Having been only recently formed it is likely the early Earth was hotter and more volcanically active than it is today. Like our neighbouring planets, Venus and Mars the atmosphere probably had a predilection for carbon dioxide, but unlike Venus – and unlike, at least today's, Mars – Earth seemed able to accommodate large quantities of liquid water which absorbed some of the carbon dioxide and avoided the runaway greenhouse effect that makes Venus the inhospitable lead-melting planet that it is today.

Liquid water is pretty much key to the whole Earth equation. As well as absorbing carbon dioxide it helps lubricate movement of the Earth's crust leading to what we now call plate tectonics. On Venus – a planet similar in mass and diameter to the Earth, there is no liquid water – and it's thought that its surface crust set solid, containing the hot magma innards of the planet like a pressure cooker, until something gave and the whole planet gets resurfaced by a catastrophic global outpouring of lava – which then sets solid and the whole pressure cooker scenario starts over.

On Earth, rather than the Earth's crustal surface being locked solid, it is actually in constant motion. Hot magma constantly rises and cools at the mid-oceanic ridges found across the planet – from which the deep sea floor slowly spreads outwards like a conveyor belt until it's subducted below the continents of cooler chunkier rock that drift above all this activity.

Though accompanied by seemingly violent earthquakes and volcanoes – this is a much gentler way of losing heat than Venus's approach – and more conducive to the development of life – and the only reason we don't find rocks earlier than 3.8 million years ago is that this earlier rock has long since been subducted back into the Earth.

The alternative more traditional view was that within this Hadean era Earth was indeed hellish, with much of the surface molten or at least vigorously volcanic – and it's this that explains the absence of any rocks persisting to today.

Under either theory something else went on between 4.1 billion and 3.8 billion years ago which would have been pretty hellish anyway. The Late Heavy Bombardment, or LHB, was a sudden a fairly catastrophic series of asteroid impacts persisting over a 300 million year period which have clearly left its mark on the Moon – though any record of these asteroid impacts on Earth has been large erased by plate tectonics – or by resurfacing in Venus's case.

Evidence for the LHB comes largely from Apollo moon rock samples, where the majority of melted rock formed from large asteroid impacts, even though collected from multiple sites, all seemed to have formed in that fairly narrow time period of 4.1 to 3.8 billion years ago.

Various theories abound about the cause of the heavy bombardment. It may have resulted from a readjustment in the orbits of the gas giants in the outer solar system which perturbed the asteroid belt leading to a rain of asteroids falling into the inner solar system.

Under such conditions, life may have had a tough time taking hold, but it is speculated that life probably did take hold fairly early. Stressing the speculative nature of this due lack of fossil evidence, it's thought the first forms of life may have been anaerobic hydrogen sulphide feeders perhaps similar to those of the Archae domain found today around deep ocean volcanic vents where they use of heat of the Earth to extract hydrogen from hydrogen sulphide (or H_2S), to create metabolic energy needed for life.

Later on, like maybe 3.8 billion years ago as the asteroid bombardment subsided and global dust clouds disappeared, the Sun may have once again shone brightly on a shiny new Earth and those little proto-critters found sunlight to be at just right energy frequency to allow them to extract hydrogen from the much more abundant H_2O that covered over two thirds of the planet.

These new organisms, commonly called cyanobacteria, set about reshaping the planet over the next two billion years – building their bodies by extracting carbon dioxide from the atmosphere and taking this carbon out of the equation when they died and fell to the sea floor – those carbon deposits being subducted back under the Earth's crust by plate tectonics – or otherwise buried under layers and layers of sediment. And of course cyanobacteria also created oxygen – which is pumped into the atmosphere by photosynthesis where it remains only temporarily before oxidising something.

What we see in those 3.8 billion year old rocks are bands of orange rust, where newly formed oxygen bonded with iron minerals in the seas, forming iron oxide – or rust which sank to the sea floor and today give us something useful to mine. Which is good… but, not so good is our propensity to mine all the ancient corpses of early life-forms which broke down into oil and natural gas – as well as the land plants which are broken down and turned into coal. As we burn this all this stuff we are steadily putting back all the carbon those ancient critters spent billion of years taking out of the atmosphere for us.

Worth thinking about – oh, along with that asteroid that's lurking somewhere out there with our name on it.

Thanks for listening. This is Steve Nerlich from Cheap Astronomy, www.cheapastro.com. Cheap Astronomy offers an educational website helping you make it so – on the cheap. No ads, no profit, just good science. Bye.