Stellar Metamorphosis: Aluminum

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Abstract: All stars contain aluminum and it is a main building block of the crusts of highly evolved stars like the Earth. A conceptual bridge is built using aluminum as an important element in the evolution of a star, into its life hosting stages and beyond. Water, hydroxides, iron, hydrogen are all included in this bridge paper.

Aluminum percentages in young stars like the Sun is really low as opposed to magnesium, oxygen, hydrogen and helium. This all changes though as the star evolves. Aluminum's per-particle abundance in the Solar System is 3.15 ppm (parts per million). It is the twelfth most abundant of all elements and third most abundant among the elements that have odd atomic numbers, after hydrogen and nitrogen. The only stable isotope of aluminum, 27 Al, is the eighteenth most abundant nucleus in the Universe. Essentially all aluminum now in existence is 27Al.

Overall, the Earth is about 1.59% aluminum by mass (seventh in abundance by mass). Aluminum occurs in greater proportion in the Earth than in the Universe because aluminum easily forms the oxide and becomes bound into rocks and aluminum stays in the Earth's crust while less reactive metals sink to the core during stellar evolution. In the Earth's crust, aluminum is the most abundant (8.3% by mass) metallic element and the third most abundant of all elements (after oxygen and silicon). A large number of silicates in the Earth's crust contain aluminum. In contrast, the Earth's mantle is only 2.38% aluminum by mass.

Because of its strong affinity for oxygen, aluminum is almost never found in the elemental state; instead it is found in oxides or silicates. Feldspars, the most common group of minerals in the Earth's crust, are aluminosilicates. Aluminum also occurs in the minerals beryl, cryolite, garnet, spinel, turquoise, corundum, etc. Impurities in Al_2O_3 (corundum), such as chromium and iron, yield the gemstones ruby and sapphire, respectively.

Although aluminum is a common and widespread element, not all aluminum minerals are economically viable sources of the metal. Almost all metallic aluminum is produced from the ore bauxite ($AlO_x(OH)_{3-2x}$).

Regarding the abundances of aluminum in the stars as they evolve from hotter states,

1. Aluminum to hydrogen content will flip-flop for stars as they age, the youngest stars will have the most hydrogen, but eventually the aluminum will match the hydrogen in mass, and then surpass the hydrogen in mass. This threshold probably happens a good bit after ocean world stages of stellar evolution, as the hydrogen escapes via water and hydroxide evaporation (hydrogen and oxygen compose water/hydroxide). This also happens while the rock bauxite is forming, which is also composed of minerals goethite, kaolinite, boehmite, gibbsite, which all contain the radical hydroxide OH-. What this means is that the deep oceans these minerals were forming in, was very chemically basic, this meaning ocean worlds that are essentially pre-Earths have basic oceans (pH's of 7 or higher). The oceans become more acidic as the stars evolve from ocean world stages to Earth stages, and then lose their water all together as the star dies and ceases the ability to host life when the oceans and soil become a 4 in pH. (If I had to make a guess, the atmospheres of pre-ocean worlds such as Neptune are very basic, which corresponds to ammonia solutions and baking soda, of pH's of 9.5-11.5.

2. The hydroxide ion is also reactive and lighter than water, so it should atmospherically escape the ocean world in larger amounts unless it is combined with the heavier, reactive elements such as nitrogen and aluminum.

3. When those elements flip flop in mass abundance is not known currently, but probably happens after the iron flip-flops. So the iron flip flops first because that is what the core forms from and is needed to begin the structure formation, and the other lighter elements battle it out afterwards.

The papers discussing that phenomenon here in the solar abundance principle:

http://vixra.org/pdf/1603.0422v1.pdf

and in the elemental mass equilibrium paper discussing when iron flip flops in stars here:

http://vixra.org/pdf/1811.0047v1.pdf

Basically the oldest stars have a higher percentage of iron by mass than hydrogen, and the youngest have much higher percentage of hydrogen by mass than iron (even alongside the fact that hydrogen is ~55 times lighter in atomic mass).

This paper will be expanded considerably in the future. There are more elements to address with regards to stellar evolution in the general theory.