JOVIAN DIAMONDS

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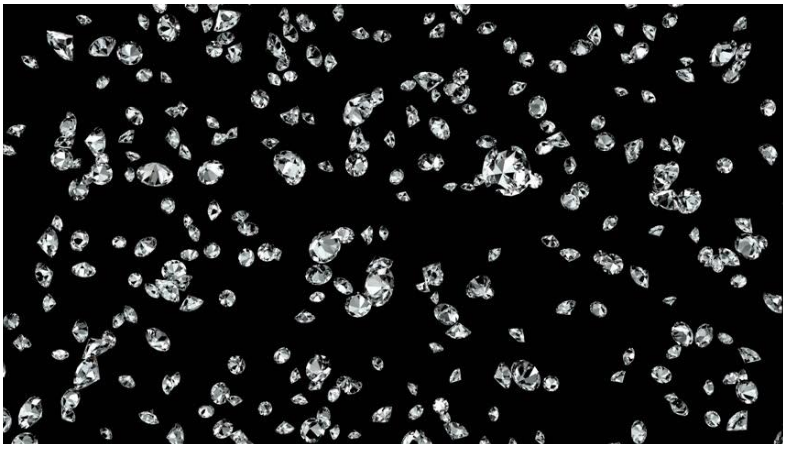
Ken Tapping, 17th September, 2024

Carbon comes in two forms. One is graphite, which is soft, black, greasy and hard to wash off clothes. It is widely used as a lubricant. Its presence is what makes fossil fuels like coal, tar or oil black. Its other form is clear, crystalline and very hard - diamond. Whether carbon is in one form or the other is determined by the conditions under which it solidifies. In our environment, graphite is the usual form.



However, under the high temperatures and extreme pressures existing deep in the Earth, diamond is the preferred form, because it is more compact. We can now duplicate those conditions, using large presses weighing hundreds of tonnes to produce the required pressure of 5 billion Pascals (730,000 psi) and temperatures of around 1,500 °C. It is likely these conditions occur on other worlds. However, one of the most bizarre processes for forming diamonds has been suggested to occur in the planet Jupiter.

Carbon is one of the by-products of energy production in stars. At certain points in their lives, some stars produce a lot. It forms grains that are pushed away from the star as part of its stellar wind and also being pushed away by radiation pressure. It accumulates in the cosmic gas and dust clouds as grains and also as an important component in a cornucopia of organic chemicals, many of which are building blocks for life. When planets form, they get rations of carbon and those organic chemicals, either from the clouds from which they form or later on through impacts of asteroids and comets.

Even though the planet Jupiter is bizarrely different from the Earth it formed the same way. This giant planet has 318 times the mass of our world and more than ten times its diameter. There is a clue there that Jupiter differs from the Earth in an important way. The mean density of our world is 5.5 grams per cubic centimetre. This is consistent with our planet being largely a lump of rock. Basalt, an important volcanic rock has a density of just under 3 grams per cubic centimetre.

The Earth's density is higher than that due to its large iron and nickel core. Jupiter has a density of 1.33, just a little higher than that of water (1 gram per cubic centimetre). To have this low a density, Jupiter must be largely a ball of gas, with possibly something small and solid in the middle. Most of that gas is made up of hydrogen, methane and ammonia. Through a small telescope, the planet is visible as a tan-coloured disc crossed by black and brown bands, with some whitish spots and a large reddish one. These colours are evidence of a witch's brew of organic chemicals.

Jupiter rotates very rapidly, despite its huge size. A day on Jupiter is about 10 hours. The rapid rotation leads to lots of storms, with lots of upflows and downflows in its atmosphere. Jupiter is still very hot inside, so organic chemicals being carried downward would find themselves exposed to extremely high pressures and temperatures. There is no oxygen, so they would not burn. They would instead decompose, with grains of carbon moving downwards under increasing heat and pressure.

The theory proposes that these would become a rain of diamonds, either contributing to an enormous diamond or two in the centre of the planet, or more likely a rocky core containing a wealth of diamonds. This is a comparatively safe theory, because it is extremely unlikely that we will ever be in a position to go there and take a look.

In our galactic neighbourhood there must have been occasional violent collisions between Jupiter-sized worlds, which means there could be a diamond asteroid or two drifting around in space.

Look for Mercury low in the dawn glow. Around midnight, Saturn lies low in the south, and Jupiter and Mars close together in the northeast. The Moon will be Full on the 17th.

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