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## Issues associated with the formation of the ocean by SCP-045

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### Abstract

Within the creative writing universe of the SCP Foundation, SCP-045 is an object that formed the Earth's oceans through magical conversion of gaseous nitrogen to liquid water. This conversion would require a large mass of gaseous nitrogen, as well as enough time for it to be converted. It also requires SCP-045 to be continuously supplied with new gaseous nitrogen. This paper discusses some of the different environmental constraints on SCP-045's ability to convert enough nitrogen into liquid water to form Earth's entire ocean.

**Keywords:** *Internet; Mathematics; Earth Sciences; Ocean; SCP-045*

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### Introduction

The SCP (Special Containment Procedures) Foundation is a fictitious organization, on the collaborative creative writing website of the same name, which contains and studies "anomalous" or otherwise fantastical entities or objects [1]. SCP-045 is one such object [2]. It is an icosahedron (a 3D shape with 20 faces) with an average radius of 1.7 m, made of ice XII, a form of water ice that usually only exists at very high pressures and temperatures [3]. It magically converts gaseous nitrogen ( $N_2$ ) within 3.7 m of itself to liquid water ( $H_2O$ ). The mechanism by which it does this is unknown, but within the lore of SCP-045, it is implied to have formed the entirety of the Earth's oceans through this conversion process. Due to the sheer size of the Earth's oceans, this is an extraordinarily large task for SCP-045, and would come with various limitations and constraints.

In real life, it is likely that Earth's oceans formed by degassing of the mantle, where water vapour escaped from molten rocks into the atmosphere, and later condensed and fell as rain when the Earth's temperature cooled to below the boiling point of water. This process occurred over many millions of years, and resulted in the oceans we have today [4].

### Mass of $N_2$ required

The anomalous/magical conversion of  $N_2$  to liquid water by SCP-045 takes place with the following ratio [2]:

$$1.00 \text{ mol } N_2 : 1.98 \text{ mol } H_2O$$

where 1 mol of  $N_2$  is 28 g, and 1.98 mol of  $H_2O$  is 35.64 g.

A number of different calculations of the mass of the oceans put it in the range of  $1.4 \times 10^{21}$  kg, or  $1.4 \times 10^{24}$  g [5]. We can find the amount of  $N_2$  required to form the ocean by dividing the mass of the ocean by the mass of 1.98 mols of water (35.64 g), followed by multiplying by the mass of 1 mol of  $N_2$  (28 g). This gives:

$$\left( \frac{1.4 \times 10^{24}}{35.64} \right) \times 28 = 1.10 \times 10^{24} \text{ g} \quad (1)$$

SCP-045 would require approximately  $1.10 \times 10^{24}$  g of  $N_2$  to produce enough water to create the entire ocean. The mean dry mass of the atmosphere in modern day is  $5.135 \times 10^{18}$  kg, or  $5.135 \times 10^{21}$  g [6]. Since the atmosphere is 75.52%  $N_2$  by mass [7], the mass of nitrogen in the Earth's atmosphere is:

$$(5.135 \times 10^{21}) \times 0.7552 = 3.878 \times 10^{21} \text{ g} \quad (2)$$

Comparing this to the mass of nitrogen required by SCP-045 gives a ratio of:

$$\frac{1.10 \times 10^{24}}{3.878 \times 10^{21}} = 283.6 \quad (3)$$

Therefore, formation of the ocean by SCP-045 would require the Earth's atmosphere to contain an amount of N<sub>2</sub> over two orders of magnitude higher than the current amount.

#### Total volume of water

SCP-045 is only able to convert N<sub>2</sub> which is within 3.7 m of any part of itself [2] – the “effective region”. Taking the shape of the effective region and the shape of SCP-045 as spheres, the total volume of SCP-045's effective region can be calculated as:

$$\frac{4\pi(1.7 + 3.7)^3}{3} - \frac{4\pi(1.7)^3}{3} = 639.00m^3 \quad (4)$$

Comparatively, the volume of the ocean is estimated as 332,519,000 cubic miles [8], which is equal to:

$$332,519,000 \times (4.168 \times 10^9) \\ = 1.38 \times 10^{18}m^3 \quad (5)$$

This is enough water to fully fill SCP-045 effective region  $2.169 \times 10^{15}$  times over. If SCP-045 was able to produce a full 639.00 m<sup>3</sup> of water per second, it would take approximately  $6.878 \times 10^6$  years (68.78 million years) for enough water to be produced.

This also assumes that SCP-045 continuously has access to new N<sub>2</sub>. Considering that the partial pressure (proportion) of N<sub>2</sub> in the atmosphere was lower than in modern day [9], this is unlikely. Time would be lost waiting for new N<sub>2</sub> to move to within SCP-045's effective region after depletion of nearby supplies, further increasing the total time needed. Taking this into account, SCP-045 would likely require close to 100 million years to produce enough water, assuming that the conversion of N<sub>2</sub> to water is very fast.

Something to note is that SCP-045 experiences brief periods of time where its radius of effect doubles in

size, from 3.7 m to 7.4 m. This would increase its total effective region to:

$$\frac{4\pi(7.4 + 1.7)^3}{3} - \frac{4\pi(1.7)^3}{3} = 3135.97m^3(6)$$

Which would increase how much atmospheric N<sub>2</sub> is available to SCP-045. However, these periods of time only last a maximum of 73 seconds, and have much longer periods of time, from 2 weeks to 3 months, between them [2]. So, while this would decrease the amount of time required for formation of the ocean, its effect would be small, and the timescale needed would still be in the order of tens, or if not, hundreds, of millions of years.

#### Ocean Depth

SCP-045 was discovered at the bottom of the Pacific Ocean [2]. The Pacific Ocean has an average depth of 4000 m [10]. This means that, once the sea level rises high enough to completely cover both SCP-045 and the entirety of its effective region, SCP-045 would struggle to acquire new supplies of N<sub>2</sub>. Therefore, SCP-045 would most likely not be able to produce a sea level that is 4000 m higher than its own location.

#### Conclusion

SCP-045's formation of the ocean through anomalous/magical conversion of atmospheric N<sub>2</sub> to liquid water poses a number of challenges to it. For SCP-045 to be able to produce enough water to form the Earth's oceans, it would require a mass of N<sub>2</sub> which is approximately 283 times larger than the amount of N<sub>2</sub> currently in Earth's atmosphere. Considering the very small effective region SCP-045 has compared to the total volume of the ocean, it would have to both acquire new supplies of N<sub>2</sub> and convert it to water very quickly to produce the volume of water present in the ocean on a reasonable Earthly timescale. This would be further hampered by the low partial pressure of N<sub>2</sub> available to it. SCP-045's location, at approximately 4000 m below sea level, also places constraints on SCP-045's ability to continually access N<sub>2</sub>.

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