

## Biosphere 2

### Overview and Short History

Biosphere 2 is a major sealed glasshouse complex near the small town of Oracle, north of Tucson in the desert of Arizona. It was completed in 1991, funded by a Texan oil billionaire, Edward P. Bass, whose vision was that it could be a step towards the colonisation of Mars by humans. With this in mind, the complex had to be large enough to support humans and to be self-sustaining, with recycling of all its components. It was designed to accommodate small teams of people who would live in it for periods of up to 2 years, obtaining all their food by growing crops or by eating domesticated animals, replenishing the oxygen by plant photosynthesis, and recycling of all their consumables. Even the toilets had no toilet tissue; instead they had an inbuilt spray for ...well, you know what!

In short, the sealed complex was designed as a model, sustainable, controlled environment system - a visionary experiment on a grand scale. It contains several different compartments, supporting different types of vegetation (biomes). It is called Biosphere 2 because it aims to mimic Biosphere I - planet Earth.

#### 1. Technical problems

Soon after the first crew entered Biosphere 2, the oxygen levels in the complex started to fall and eventually reached damagingly low levels - below 14.5% compared with the normal 21% [14.5% is the oxygen level found at an altitude of about 4100 metres (13,400ft)] This low oxygen level caused fatigue (equivalent to altitude sickness) and threatened the inhabitants' wellbeing. It is said that the inhabitants lacked the energy to climb the 100 or so stairs to the library (see Figure -), so this facility soon became non-functional. In addition, the nitrous oxide and CO<sub>2</sub> concentrations rose to high levels. In order to help manage these problems, it was decided that the giant "lungs" (which compensated for changes in air volume) would be opened to the exterior when they were fully dilated each day, so that some fresh air could be introduced into the "closed" environment. Later, it even became necessary to pump oxygen into the system. Much of the reason for this oxygen deficit seems to be that oxygen was absorbed by some of the concrete structures in Biosphere 2 - the "curing" process of new concrete - and this was subsequently overcome by sealing the concrete. However, it is likely that a contributory cause of oxygen depletion (and CO<sub>2</sub> increase) was the high organic matter content of the original soils (see later).

Added to these problems, there was some air leakage, estimated at about 10% per annum, between the inside and the external atmosphere. It has been pointed out that this amount of leakage is almost inevitable - in fact, it is similar to the leakage from spacecraft - but it caused some critics (including a skeptical press) to claim that the whole basis of the project - a sealed environment - was invalidated by air leakage and by the need to open the lungs to the outside world.

## **Biosphere 2, cont. Overview and Short History**

### **2. Human and social problems**

The biosphere inhabitants soon found that they could not generate enough food to sustain themselves. They had brought in various seeds (peanuts, maize, vegetables, etc. - even coffee) which would be sown to produce crops (and which would generate more seeds for subsequent seasons). These annual crops were grown in rotation in 18 separate plots in the agroforestry zone. They included rice, wheat, maize, sorghum, sweet potato, potatoes, beans, soybeans, rape, mustard, safflower, tomatoes, cabbage, carrots; eggplant (aubergine), peppers and leafy vegetables.

But the biospherians were not experienced agronomists, and they had many problems with insect pests and plant diseases because they had to rely on natural (biological) control practices rather than chemical pest control measures, and the biological control methods did not always work well. As their food crisis deepened, the biospherians decided to eat some of the stores of seeds they had brought in, which were intended to be used to produce more food. At quite an early stage they found that bananas were one of the easiest and most nutritious food sources that they could use (in the rainforest zone) so they allowed the bananas to proliferate naturally (from rhizomes), and bananas now dominate that zone.

The initial intention was that chickens would be used as a continuing source of eggs, but the biospherians could not afford to use the limited amounts of food to feed the chickens, so these were slaughtered and eaten. The pigs also were in competition with the food demands of the humans. So, the pigs were slaughtered and eaten.

The biospherians were perpetually hungry and lost an average 16% of their body weight in the first 6 months (then stabilised thereafter). Despite this, they remained physically healthy. In fact, one of the more lasting scientific contributions from Biosphere 2 has been the recognition that a restricted (energy-limited) diet can increase health and longevity, as long as it is a "nutrient-dense" diet, with all the essential ingredients.

There were inevitable interpersonal difficulties, doubtless exacerbated by living so intimately as a group, in the highly stressful conditions. According to a report on a talk given later by one of the initial participants, Jayne Poynter, "the crew split into two factions about 6 months into the mission and from that point on, the two groups worked together, but could not get along. Their differences curtailed creativity and caused communication problems."