Dig deeper to find Martian life

Probes designed to find life on Mars do not drill deep enough to find the living cells that scientists believe may exist well below the surface of Mars, according to research led by UCL (University College London). Although current drills may find essential tell-tale signs that life once existed on Mars, cellular life could not survive the radiation levels for long enough any closer to the surface of Mars than a few metres deep – beyond the reach of even state-of-the-art drills.

The study, published in the journal *Geophysical Research Letters* (GRL), maps out the cosmic radiation levels at various depths, taking into account different surface conditions on Mars, and shows that the best place to look for living cells is within the ice at Elysium, the location of the newly discovered frozen sea on Mars.

The lead author, Lewis Dartnell, UCL Centre for Mathematics and Physics in the Life Sciences & Experimental Biology (CoMPLEX), said: "Finding hints that life once existed – proteins, DNA fragments or fossils – would be a major discovery in itself, but the Holy Grail for astrobiologists is finding a living cell that we can warm up, feed nutrients and reawaken for studying.

"It just isn't plausible that dormant life is still surviving in the near-subsurface of Mars – within the first couple of metres below the surface – in the face of the ionizing radiation field. Finding life on Mars depends on liquid water surfacing on Mars, but the last time liquid water was widespread on Mars was billions of years ago. Even the hardiest cells we know of could not possibly survive the cosmic radiation levels near the surface of Mars for that long."

Survival times near the surface reach only a few million years. This means that the chance of finding life with the current probes is slim. Scientists will need to dig deeper and target very specific, hard-to-reach areas such as recent craters or areas where water has recently surfaced.

Dr Andrew Coates, UCL Department of Space & Climate Physics, said: "This study is trying to understand the radiation environment on Mars and its effect on past and present life. This is the first study to take a thorough look at how radiation behaves in the atmosphere and below the surface and it's very relevant to planned missions. The best chance we have of finding life is looking in either the sea at Elysium or fresh craters."

The team found that the best places to look for living cells on Mars would be within the ice at Elysium because the frozen sea is relatively recent – it is believed to have surfaced in the last five million years – and so has been exposed to radiation for a relatively short amount of time. H2O provides an ideal shield of hydrogen to protect life on Mars from destructive cosmic radiation particles. Ice also holds an advantage because it is far easier to drill through than rock. Even here, surviving cells would be out of the reach of current drills. Other ideal sites include recent craters, because the surface has been exposed to less radiation, and the gullies recently discovered in the sides of craters, as they are thought to have flowed with water in the last five years.

The team developed a radiation dose model to study the radiation environment for possible life on Mars. Unlike Earth, Mars is not protected by a global magnetic field or thick atmosphere and for billions of years it has been laid bare to radiation from space. The team quantified how solar and galactic radiation is modified as it goes through the thin Martian atmosphere to the surface and underground.

Three different surface scenarios were tested; dry regolith, water ice, and regolith with layered permafrost. The particle energies and radiation doses were measured on the surface of Mars and at regular depths underground, allowing the calculation of cell survival times.

The team took the known radiation resistance of terrestrial cells combined with the annual radiation doses on Mars to calculate the survival time of dormant populations of the cells. Some strains are radiation-resistant and are able to survive the effects because, when active, they successfully repair the DNA breaks caused by ionising radiation. However, when cells are dormant, such as when frozen as in the subsurface of Mars, they are preserved but unable to repair the damage, which accumulates to the point where the cell becomes permanently inactivated.

Mr Dartnell said: "With this model of the subsurface radiation environment on Mars and its effects on the survival of dormant cells we have been able to accurately determine the drilling depth required for any hope of recovering living cells. We have found that this suspected frozen sea in Elysium represents one of the most exciting targets for landing a probe, as the long-term survival of cells here is better than underground in icy rock. This could be crucial for the scientists and engineers planning future Mars missions to find life."

Source: University College London