conformation. This would cause the E2~UBL bound to E1 to clash with UBA3, promoting the departure of E2~UBL. This ingenious mechanism ensures an irreversible flow of UBL molecules from E1 via E2 to a substrate bound to E3.

Some mechanistic aspects of the E1–E2 transfer process remain to be addressed. The A-site and the T-site of E1 are separated by the prominent crossover loop of UBA3 (Fig. 1a). How, then, does the topologically challenged transfer of the UBL between these sites occur? Two mechanisms suggest themselves: either the adenylated tail of the UBL changes conformation and comes close to the active cysteine in the T-site, or the UBA3 catalytic domain undergoes a conformational change that allows this cysteine to reach the A-site. It might be possible to distinguish between these two mechanisms by determining the structure of an E1 in complex with an adenylated UBL.

Finally, an interesting parallel can be drawn between the mechanism proposed by Huang *et al.*[4] and the E2–E3-catalysed attachment of ubiquitin to its protein targets. A structural model of an E2–E3 complex has been proposed[9] in which there is a large gap between the active cysteine of E2 and the substrate that is bound to E3. Could the conformational change reported by Huang *et al.* be a model mechanism for other reactions in signalling pathways involving UBLs? ■

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PLANETARY SCIENCE

Inside Enceladus

John Spencer and David Grinspoon

Chemical analysis of a plume emanating from near the south pole of Enceladus indicates that the interior of this saturnian moon is hot. Could it have been hot enough for complex organic molecules to be made?

Tiny, icy Enceladus is, at a mere 500 kilometres in diameter, Saturn's sixth-largest moon. But thanks to the discovery in July 2005, by NASA's Cassini Saturn orbiter, of a remarkable water-rich plume jetting from warm fractures near Enceladus's south pole[1–3] (Fig. 1), the satellite has rivalled the giant moon Titan as a focus of attention in the Saturn system. In a paper to be published in *Icarus*, Matson *et al.*[4] suggest that the plume may be the external manifestation of a chemically rich, subsurface hydrothermal system that reaches temperatures of more than 200 °C.

This activity offers planetary scientists the first real possibility in the Solar System of studying cryovolcanism — volcano-like activity involving ices, rather than the molten silicates of earthly volcanoes — as it happens. The plume is also an unprecedented opportunity for direct analysis, with Cassini's instruments, of material that was in the interior of an icy satellite only minutes earlier. Of the issues to be resolved on Enceladus, one of the most interesting is that of the moon's internal temperature distribution. This controls its potential for sustaining liquid water, the chemistry that is possible, and even the potential suitability of the moon as a habitat for life.

The highest surface temperatures measured directly by Cassini's thermal infrared imaging instrument are about 145 K (–128 °C)[2], although a temperature of at least 180 K at the plume's source can be inferred indirectly. It has been suggested[3] that the comparable masses of gaseous and solid H_2O in the plume calculated from the Cassini data are produced most easily if the plume is generated by the boiling of liquid water into the vacuum of space, implying a temperature near the surface of at least 273 K (0 °C), the melting point of ice. But this startling conclusion is by no means certain. For one thing, the gaseous water in the plume seems to be moving much faster than most of the ice particles[1,3]. Thus, to sustain the ratio of ice particles to gas in the plume, which is measured to be near 1, much more gas must be produced than ice. Direct condensation from the vapour phase, without involvement of liquid water, may be sufficient to produce the ice particles at the observed rate. The plume might also be produced[5] by explosive release of gas from 'clathrate' water ice, which has other molecules trapped in its crystal lattice, at temperatures well below 0 °C.

Whatever Enceladus's near-surface temperatures, things are presumably warmer deeper down. A subsurface ocean of liquid water, as is now thought to exist under the icy crust of Jupiter's moon Europa, is also possible on Enceladus — although direct evidence for such a thing is so far lacking. Matson *et al.*[4],

50 & 100 YEARS AGO

50 YEARS AGO

Swifts in a Tower. By Dr. David Lack — The domestic life of the swift...was until lately almost unknown, because it nests in holes which are commonly inaccessible, on high buildings, and often too far into these to be reached in any event. This book, however, describes ten years of observation of nesting swifts 'from the inside'. The opportunity was offered by the colony in the ventilation holes in the tower of the University Museum at Oxford (associated in memory with the historic debate on evolution between Huxley and Wilberforce); it was ingeniously taken, by the insertion of nesting boxes with lids and glass panels to study the birds at closest quarters from within the tower. Many ornithologists and others have climbed the tall interior ladders to see the birds, which are unafraid of approach in these circumstances; but it is to many hours of patient observation by the author, and by his wife and other assistants, that we owe the wealth of information now presented in such attractive form. The results are of great interest, and are illustrated by remarkable electronic flash photographs by Mr H. N. Southern.

ALSO

Mr. Duncan Sandys, Minister of Housing and Local Government, has confirmed an order establishing the Gower Peninsula, Glamorgan, as an area of outstanding natural beauty... the first of its kind under the National Parks and Access to the Countryside Act, 1949.

From *Nature* 26 January 1957.

100 YEARS AGO

The pipe line conveying petroleum from Baku to the Black Sea has been completed. It is 550 miles long, and is capable of passing 400,000,000 gallons of oil yearly. Another important oil-pipe line has been built for transporting Texas and California petroleum across the Isthmus of Panama. It is 8 inches in diameter and fifty-one miles long.

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