appear in Freeman's Fig. 1 (though not obviously in his Fig. 3) that the less plausible surface shapes are also less smooth — a greater area of the planar background is disrupted.

One explanation of the link between surface smoothness and generality of illumination is as follows. For diffuse ('Lambertian') illumination, image-intensity is given by the 'rendering function' $\mathbf{l}\cdot\mathbf{n}$ where $\mathbf{n}$ is the surface normal vector at each image position and vector $\mathbf{l}$ represents the strength and direction of the light source. In that case Freeman's measure of genericity of illumination (equation 7) is $1/\sqrt{\det(\langle \mathbf{n}\mathbf{n}^T \rangle)}$, where $\langle \_\_ \rangle$ denotes spatial averaging over the image. This measure becomes unboundedly large as the visible surface approaches planarity because the normal vectors $\mathbf{n}$ span a space of only one dimension, so the det(..) term approaches zero. (Something similar also happens as the surface becomes close to cylindrical.) After all, therefore, as the underlying surface becomes smooth in the sense of approaching planarity, the measure of generality of illumination becomes large. The question is whether this link suggests that Freeman's approach might somehow be limited to smooth surfaces.

Overall, however, Freeman's specific achievement is impressive, both in seeing a way to express probabilistically the general illumination assumption and to some extent verifying experimentally its power to reject incorrect hypotheses about surface shape. The claim for greater generality is not altogether convincing as yet. It will be interesting to see whether computational experiments can establish more precisely the breadth of conditions over which the theory is viable. □

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GEOCHEMISTRY

Catalysing methane production

Everett L. Shock

THE reactions that produce methane and other light hydrocarbons in sedimentary basins are poorly understood, despite the considerable faith of petroleum geologists in thermal decomposition of organic matter with progressive burial. As with many widely held beliefs (especially in organic geochemistry), the faith of the followers has little to do with the quantitative strength of the hypothesis. Given the geological, geochemical, experimental and theoretical assault now being made on this conventional wisdom, it is not surprising that researchers are proposing new mechanisms and pathways to account for both the widespread occurrence of natural gas and the predominance of methane in that gas. Catalysis is the key, and catalysis by transition metals in organic-rich source rocks was proposed two years ago by Mango[1]. Together with Hightower and James, Mango now provides experimental support for this idea on page 536 of this issue[2].

Mounting evidence indicates that the formation of light hydrocarbons in sedimentary basins is not governed by the thermal instability of organic compounds. Mango has argued for some time[3–6] that the distribution of light hydrocarbons in petroleum is inconsistent with thermal fragmentation of larger organic compounds. His observation complements the work of L. C. Price[7], who has assembled extensive geological and geochemical evidence that hydrocarbons survive conditions at which they were once thought to be destroyed.

Meanwhile, thermodynamic calculations led Sato to the conclusion[8] that increased temperature during burial of organic matter in sedimentary basins does not affect the position of equilibrium in the C–H–O system, but simply increases the rates of otherwise extremely slow reactions. Such reactions lead inevitably to a lower overall free energy for the system; Helgeson and co-workers, including myself, have demonstrated this, and argue for the development of metastable equilibrium states among petroleum, oil field brines and the minerals in reservoir rocks[9].

The arrival at metastable equilibrium states is apparently driven by the irreversible hydrolytic disproportionation of petroleum to light hydrocarbons, especially methane, and the extent to which the gas can escape from the geological system. Therefore, the mechanisms through which the thermodynamically favoured but kinetically inhibited formation of methane can be catalysed are central to the next steps in understanding geo-

RÉSUMÉ

Lightning shot

FASTER than a speeding bullet? A group at Sandia National Laboratories has accelerated a 6-mm-diameter disk of metal to a new record velocity for a macroscopic object. Their multi-stage accelerator works as follows: a powder gun fires a piston down the first, wide-bore barrel to compress a column of hydrogen gas. The gas bursts into a second, narrower barrel where it accelerates a soft-nosed cylindrical projectile to strike the final titanium-alloy disk, sending it flying at velocities up to 15.8 km s^{-1}. This is over 25 times faster than a rifle bullet and, more to the point, about twice the velocity of a satellite in low Earth orbit. So the developers, P. L. Stanton, L. C. Chhabildas and colleagues, are using their 'hypervelocity' gun to reproduce in the laboratory the possible effects of head-on collisions between the proposed space station and orbiting debris.

Proactive profilin

PROFILIN is a protein that keeps cytoplasmic actin in order by sequestering, as was supposed, the monomeric form and thus limiting the proportion that could polymerize. The truth, it turns out, is more complex— and more interesting. Writing in the *Proceedings of the National Academy of Sciences* (**91**, 1510–1514; 1994), T. Finkel and colleagues describe how they have discovered that when a cell line is made to over-express profilin the amount of filamentous actin actually increases. At the same time, the actin bundles that traverse the cytoplasm, and should be the stablest of all, vanish and give place to an increased mass of anisotropic actin close to the plasma membrane. Such effects are also seen when cells are activated by growth factors. How a monomer-binding protein can promote polymerization and how the attendant consequences come about are now matters of some moment.

Low down

OZONE values fell to unprecedented lows over the United States last year, continuing the trend that began in May 1992, says a new report by W. D. Komhyr and co-workers (*Geophys. Res. Lett.* **21**, 201–204; 1994). Their results come from Dobson spectrophotometers at eight ground-based stations on the US mainland, Hawaii and Samoa, five of which have continuous records dating back to the 1960s. For over 40 per cent of the time between January and August 1993 the ozone amounts measured at these stations were more than 3 standard deviations lower than the norm, a consistent drop unrivalled in previous records. Perhaps most worryingly, average values were 8.5 per cent down during May to August, the months when solar ultraviolet insolation is at its strongest.