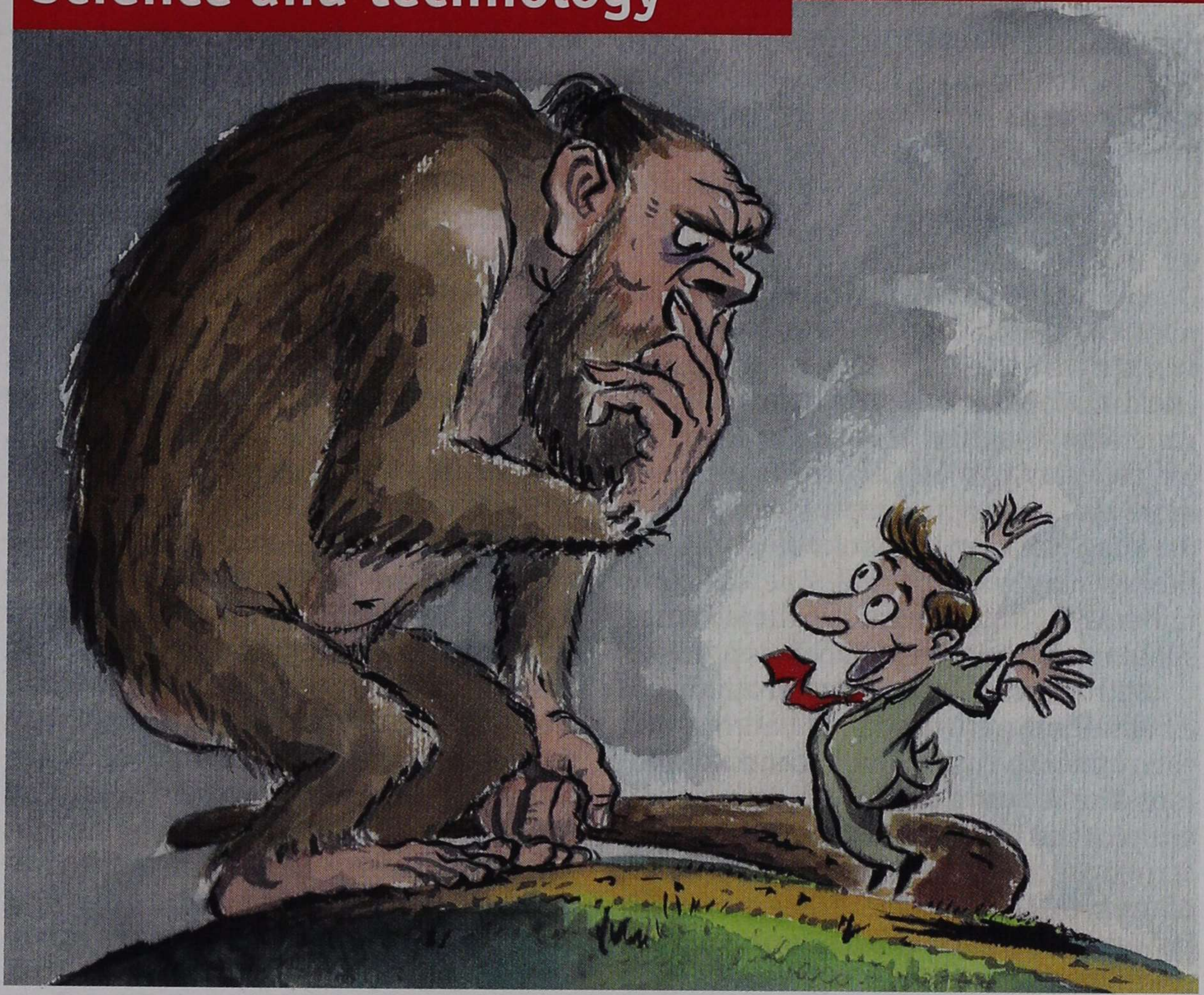

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The evolution of generosity

Welcome, stranger

The human impulse to be kind to unknown individuals is not the biological aberration it might seem

THE extraordinary success of *Homo sapiens* is a result of four things: intelligence, language, an ability to manipulate objects dexterously in order to make tools, and co-operation. Over the decades the anthropological spotlight has shifted from one to another of these as the prime mover of the package, and thus the fundament of the human condition. At the moment co-operation is the most fashionable subject of investigation. In particular, why are humans so willing to collaborate with unrelated strangers, even to the point of risking being cheated by people whose characters they cannot possibly know?

Evidence from economic games played in the laboratory for real money suggests humans are both trusting of those they have no reason to expect they will ever see again, and surprisingly unwilling to cheat them—and that these phenomena are deeply ingrained in the species's psychology. Existing theories of the evolution of trust depend either on the participants being relatives (and thus sharing genes) or on their relationship being long-term, with each keeping count to make sure the overall benefits of collaboration exceed the costs. Neither applies in the case of passing strangers, and that has led to speculation that something extraordinary, such as a need for extreme collaboration prompted by the emergence of warfare that uses weapons, has happened in recent human evolution to promote the emergence of an instinct for unconditional generosity.

Leda Cosmides and John Tooby, two doyens of the field, who work at the University of California, Santa Barbara, do not agree. They see no need for extraordinary mechanisms and the latest study to come from their group (the actual work was done by Andrew Delton and Max Krasnow, who have just published the results in the *Proceedings of the National Academy of Sciences*) suggests they are right. It also shows the value of applying common sense to psychological analyses—but then of backing that common sense with some solid mathematical modelling.

Be seeing you

Studying human evolution directly is obviously impossible. The generation times are far too long. But it is possible to isolate features of interest and examine how they evolve in computer simulations. To this end Dr Delton and Dr Krasnow designed software agents that were able to meet up and interact in a computer's processor.

The agents' interactions mimicked those of economic games in the real world, though the currency was arbitrary "fitness units" rather than dollars. This meant that agents which successfully collaborated built up fitness over the period of their collaboration. Those that cheated on the first encounter got a one-off allocation of fitness, but would never be trusted in the future. Each agent had an inbuilt and heritable level of trustworthiness (ie, the likelihood that it would cheat at the first opportunity) and, in each encounter it had, it was assigned a level of likelihood (detectable by the other agent) that it would be back for further interactions.

After a certain amount of time the agents reproduced in proportion to their accumulated fitness; the old generation died, and the young took over. The process was then repeated for 10,000 generations (equivalent to about 200,000 years of human history, or the entire period for which *Homo sapiens* has existed), to see what level of collaboration would emerge.

The upshot was that, as the researchers predicted, generosity pays—or, rather, the cost of early selfishness is greater than the cost of trust. This is because the likelihood that an encounter will be one-off, and thus worth cheating on, is just that: a likelihood, rather than a certainty. This fact was reflected in the way the likelihood values were created in the model. They were drawn from a probability distribution, so the actual future encounter rate was only indicated, not precisely determined by them.

For most plausible sets of costs, benefits and chances of future encounters the simulation found that it pays to be trusting, even though you will sometimes be cheated. Which, if you think about it, makes perfect sense. Previous attempts to study the ▸▸

evolution of trust using games have been arranged to make it clear to the participants whether their encounter was a one-off, and drawn their conclusions accordingly. That, though, is hardly realistic. In the real world, although you might guess, based on the circumstances, whether or not you will meet someone again, you cannot know for sure. Moreover, in the ancient world of hunter-gatherers, limited movement meant a second encounter would be much more likely than it is in the populous, modern urban world.

No need, then, for special mechanisms to explain generosity. An open hand to the stranger makes evolutionary as well as moral sense. Except, of course, that those two senses are probably, biologically speaking, the same thing. But that would be the subject of a different article. ■

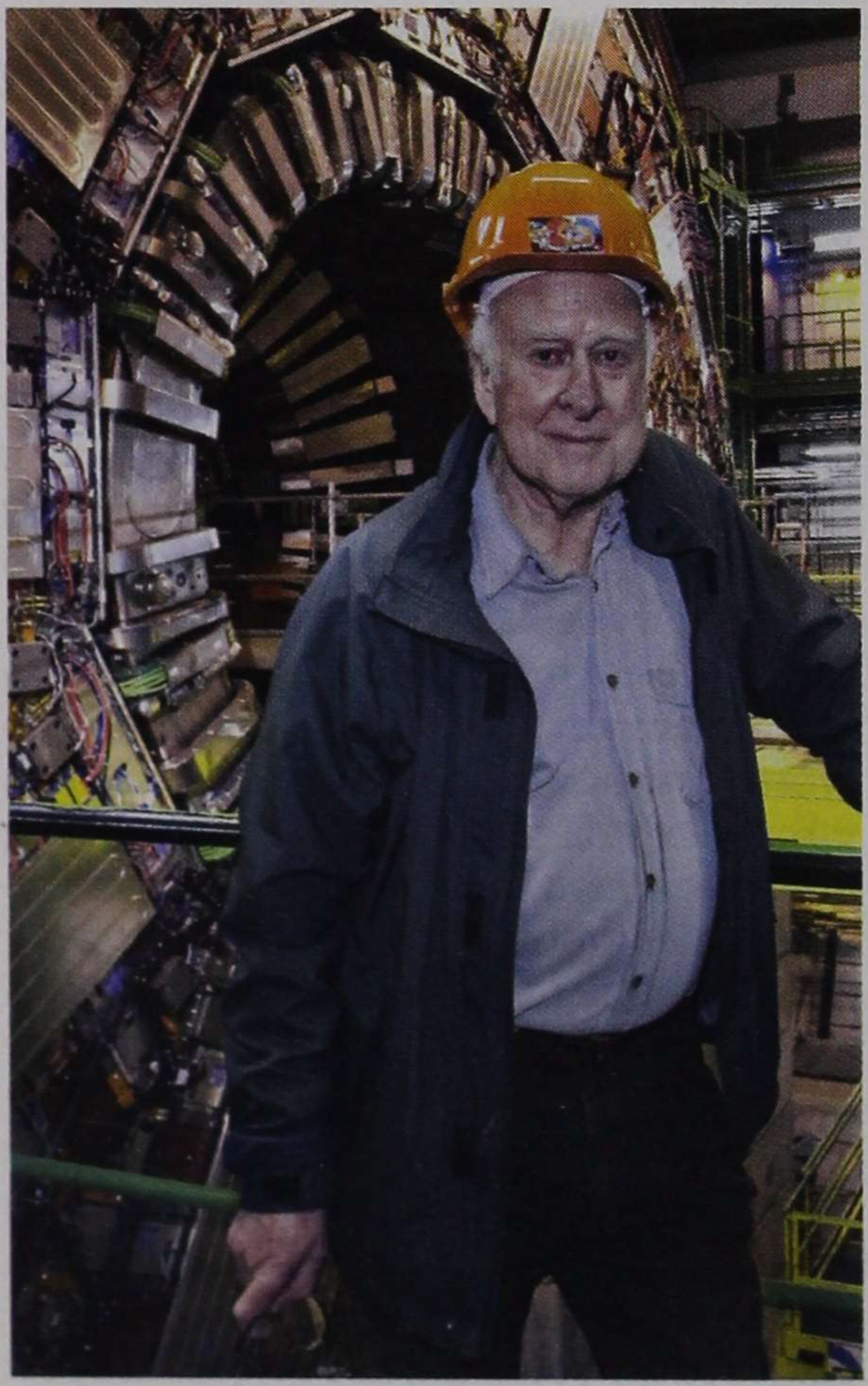
Looking for the Higgs

Enemy in sight?

GRENOBLE

The search for the Higgs boson is closing in on its quarry

ON JULY 22nd two teams of researchers based at CERN, Europe's main particle-physics laboratory, near Geneva, told a meeting of the European Physical Society in Grenoble that they had found the strongest hints yet that the Higgs boson does, in fact, exist. The Higgs (named after Peter Higgs, a British physicist who predicted its existence) is the last unobserved part of the Standard Model, a 40-year-old theory which successfully describes the behaviour of all the fundamental particles and forces of nature bar gravity. Mathematically, the Higgs is needed to complete the model because, otherwise, none of the other particles would have any mass.



Professor Higgs and the LHC

The problem with the elusive boson is not creating it in the first place. Two of the world's particle accelerators, the Large Hadron Collider (LHC) at CERN and its American rival, the Tevatron at Fermilab on the outskirts of Chicago, each have more than enough oomph to conjure up the Higgs—at least if it looks anything like theory suggests it should. The difficulty, rather, is spotting signs of it in the jetsam of subatomic debris these machines produce.

Both laboratories use similar approaches: smashing particles called hadrons into each other. The LHC collides beams of protons. The Tevatron works with protons and antiprotons. In each case the particles concerned are accelerated to within a whisker of the speed of light before they are forced, head-on, into each other. During such a collision, their kinetic energy is converted into other particles (since, as Einstein showed, energy and mass are but two sides of the same coin). The more kinetic energy there is, the heavier these daughter particles can be. Unfortunately hadrons, such as protons and antiprotons, are made of smaller bits called quarks. As a result, hadron collisions can be messy and difficult to interpret.

If a Higgs were to be made in such a collision, the complexity of hadrons means that other particles would be created along with the boson. Both it and its companions would then decay almost instantly into a plethora of less fleeting bits, some of which could be detected. In theory, analysing this shower of daughter particles should give away whether or not a Higgs was involved. But other sorts of subatomic process that do not involve the Higgs can produce precisely the same final readings as those the missing boson is predicted to generate. Finding a Higgs-like signal among the daughters is therefore not, by itself, enough to say you have discovered the Higgs. What is needed is an unexpected abundance of such signals. And it is just such excess that two separate experiments at the LHC, known as CMS and ATLAS, have detected.

Individually, each team's result could be a statistical fluke. Neither reaches the exacting standard of proof that particle physicists require to accept a result unequivocally—namely one chance in 3.5m that it occurred by accident. Instead, they each achieved a significance of somewhere between one chance in 1,000 and one in six, depending on which statistical test you use. What set the scientists gathered in Grenoble aflutter, though, was that both experiments ascribed the excesses they observed to the same putative decay pattern—one involving W bosons, which mediate the weak nuclear force that is responsible for certain types of radioactive decay. Both teams also ascribe the same mass to their putative Higgses, namely 130-150 gigaelectron-volts (the units in which particle physicists measure mass). That is at the low end of the predicted range.

Sadly, even taken together these results are far from robust enough to claim the Higgs's discovery. With a little tweaking, the Standard Model might explain them in other ways. Guido Tonelli and Fabiola Gianotti, who head CMS and ATLAS respectively, therefore urge caution. Their goal is to have enough data by the end of the year either to say definitely that the Higgs has a mass of 130-150 gigaelectron-volts, or that if it exists at all, then it must be heavier than that. If this is the case, the hunt will continue at higher and higher energies (and therefore masses) until either the thing is found, or there is nowhere left in the energy landscape for it to be hiding. ■

Prospecting for oil

Grains of truth

HOUSTON, TEXAS

Putting rocks in medical scanners may help the search for oil and gas

STRIKING oil is one thing. Getting it out of the ground in economic quantities is quite another. Doing so depends on understanding the granular structure of the rock it is trapped in, and analysing that is a tedious business of placing countless samples in pressure vessels to assess their capacity to hold hydrocarbons and to estimate the flow rate of those hydrocarbons through them. This can take years.

Help, though, is at hand. Computerised tomography (CT) scanning has been used in medicine for several decades. Now it is being applied to geology. In alliance with electron microscopy, the geological use of CT scanning has given birth to a new field, digital rock physics. The field's proponents believe it will let oil companies decide far more quickly than they could in the past which strikes are worth exploiting, and which should be abandoned.

One of those proponents is Amos Nur, chief technology officer at Ingrain, a company based in Houston, Texas. His firm is one of three independent digital-rock-physics laboratories in the world. (The other two are Numerical Rocks in Trondheim, Norway, and Digitalcore in Canberra, Australia.) According to Dr Nur, the new technology is capable of creating three-dimensional pictures of a sample's structure with a resolution of 50 nanometres. That is ▸▸