

at Johns Hopkins University in Baltimore, Maryland. The data have yielded new ways to classify tumours and pointed to previously unrecognized drug targets and carcinogens. But some researchers think that sequencing still has a lot to offer. In January, a statistical analysis of the mutation data for 21 cancers showed that sequencing still has the potential to find clinically useful mutations (M. S. Lawrence *et al.* *Nature* **505**, 495–501; 2014).

On 2 December, Staudt announced that once TCGA is completed, the NCI will continue to intensively sequence tumours in three cancers: ovarian, colorectal and lung adenocarcinoma. It then plans to evaluate the fruits of this extra effort before deciding whether to add back more cancers.

EXPANDED SCOPE

But this time around, the studies will be able to incorporate detailed clinical information about the patient's health, treatment history and response to therapies. Because researchers can now use paraffin-embedded samples, they can tap into data from past clinical trials, and study how mutations affect a patient's prognosis and response to treatment. Staudt says that the NCI will be announcing a call for proposals to sequence samples taken during clinical trials using the methods and analysis pipelines established by the TCGA.

The rest of the International Cancer Gene Consortium, slated to release early plans for a second wave of projects in February, will probably take a similar tack, says co-founder Tom Hudson, president of the Ontario Institute for Cancer Research in Toronto, Canada. A focus on finding sequences that make a tumour responsive to therapy has already been embraced by government funders in several countries eager to rein in health-care costs, he says. "Cancer therapies are very expensive. It's a priority for us to address which patients would respond to an expensive drug."

The NCI is also backing the creation of a repository for data not only from its own projects, but also from international efforts. This is intended to bring data access and analysis tools to a wider swathe of researchers, says Staudt. At present, the cancer genomics data constitute about 20 petabytes (10^{15} bytes), and are so large and unwieldy that only institutions with significant computing power can access them. Even then, it can take four months just to download them.

Stimulus funding cannot be counted on to fuel these plans, acknowledges Staudt. But cheaper sequencing and the ability to use biobanked biopsies should bring down the cost, he says. "Genomics is at the centre of much of what we do in cancer research," he says. "Now we can ask questions in a more directed way." ■



Marine biologist Sang-Mook Lee has pushed for academic involvement in South Korea's research ships.

OCEANOGRAPHY

Korea opens up its ocean science

Ships used mainly for seabed surveys will expand in focus.

BY MARK ZASTROW

South Korea's ocean-going research programme is changing tack. For more than two decades, it has focused on discovery and exploitation of minerals on the sea floor, but now a move is afoot to expand the research agenda. A 5,900-tonne ship — the *Isabu* — is being built with the capability to launch autonomous underwater vehicles, perform sea-floor-penetrating seismic surveys and collect sediment cores up to 40 metres long.

The current flagship, the 1,422-tonne *Onnuri*, spends about three-fifths of its time scouring the sea floor for mineral deposits under the direction of the deep-sea minerals group at the Korean Institute of Ocean Science and Technology (KIOST) in Ansan. That heavy economic emphasis is set by the Ministry of Oceans and Fisheries, which oversees KIOST as well as the nation's ports and shipping.

The ministry's hold is so complete that in 22 years of operation, no academic researcher outside KIOST has ever led a cruise. "This is really scandalous," says marine geophysicist Sang-Mook Lee of Seoul National University. Although scientists at his university and elsewhere have been able to work aboard the ship, they have been frustrated by a near-complete lack of say in where the *Onnuri*

goes or what research questions it pursues.

In March, that is set to change: KIOST will start to make *Onnuri*'s upcoming cruise tracks public, and will invite outside researchers to propose projects that can be done along the way, says Gi-Hoon Hong, who became the institute's president in August and has supported broadening the constituency for its research vessels. Eventually, time on the ships, which currently costs up to US\$12,000 per day, will be awarded through a merit-based system.

South Korea's focus on mineral exploration dates back to the founding of KIOST in the early 1970s, when the nation was in the middle of a decades-long economic boom. At the time, polymetallic nodules — balls of manganese and other metals such as iron, nickel and cobalt that accumulate on the sea floor — seemed a valuable potential resource. Although international interest in the minerals waned over subsequent decades, the South Korean government continued to fund research on the nodules and other sea-floor mineral deposits.

Securing marine mineral resources is "considered very important to the Korean people, because of the scarcity of land-based natural resources," says Jai-Woon Moon, the head of KIOST's deep-sea mineral research group. And rising prices for metals have renewed the world's interest: Nautilus Minerals of ▶

► Toronto, Canada, claims to be two years away from starting to extract gold, copper and other metals from a sea-floor site off Papua New Guinea.

But there is widespread scepticism of seabed mining. Lee calls the promised economic benefits “a big lie that the governments of Korea, China and India tell to their people”. Kyungsik Choi, a marine sedimentologist at Seoul National University, dismisses Nautilus Minerals and other commercial operations as not economically viable, and says that they will provide “nothing more than demonstrations”. Many in the Korean marine-science community say that KIOST itself is divided, with staff scientists chafing against the mining agenda imposed by the oceans ministry.

PUBLIC DEBATE

The long feud between the ministry and its critics reached a flashpoint in 2008, with the proposal to build the *Isabu*. The Korea Development Institute, a think tank in Sejong that is charged with evaluating major government projects, sided with the critics, saying that the economic benefits of sea-floor mining were uncertain. It approved the ship's construction, but on the condition that the academic community have access to it. A panel of researchers headed by Lee later recommended that the ship be managed by a committee with representatives from government, academia and industry. But in 2013, the oceans ministry transferred management to KIOST in a closed process. At the time, it was deemed most cost-effective for KIOST to both operate the vessel and direct its research, says Hyuntae Kim, director of the ministry's development division.

Disappointed by the move, Lee turned to a public forum. As one of the nation's most celebrated scientists and a well-known advocate for the rights of people with disabilities (he was paralysed from the neck down in a 2006 motor-vehicle accident), he testified in the national legislature on 24 October, accusing the oceans ministry of cutting a secret deal with KIOST. By the end of his appearance, then-minister Ju-Young Lee agreed to open up *Isabu* to the academic community, clearing a path for the merit-review process.

With the prospect of leading a major oceanographic cruise now open to him, Choi says that he hopes to take *Isabu* to the Indian Ocean. He wants to help nations in southeast Asia such as Myanmar and Bangladesh, which have extensive low-lying coastal deltas, to better understand the threat posed by sea-level rise and tsunamis.

Owing to his disability, Lee can no longer sail on cruises. But he says that he takes satisfaction in knowing that he has been able to wield his fame for a positive result. “I felt very good that, yes, this is compensation for my injury,” he says. “I felt redeemed.” ■



SCOTT HOUSTON/STORMA/CORBIS

Special K, or ketamine, a favourite drug at raves, is being considered as a treatment for depression.

PHARMACEUTICALS

Rave drug tested against depression

Companies and clinicians turn to ketamine to treat mental-health disorder as pipeline of new drugs dries up.

BY SARA REARDON

Ketamine, a psychoactive ‘party drug’ better known as Special K, has pharmaceutical companies riding high. Used clinically as an anaesthetic in animals and humans, it has proved an extremely effective treatment for depression, bipolar disorder and suicidal behaviour.

It also works incredibly fast. Unlike conventional antidepressants, which generally take weeks to start working, ketamine lifts depression in as little as two hours. “It blew the doors off what we thought we knew about depression treatment,” says psychiatrist James Murrough at Mount Sinai Hospital in New York City.

Companies are racing to develop patentable forms of the drug, and researchers are battling to understand how it affects the brain. An increasing number of clinicians are prescribing ketamine off-label for their patients, even as some of their colleagues worry that too little is known about its long-term effects.

The excitement over ketamine shows how badly new depression drugs are needed, says Thomas Insel, director of the US National Institute of Mental Health (NIMH) in

Bethesda, Maryland. Many drug companies have closed their mental-health divisions in the past five years, and there have been no significant advances in medication for depression in decades.

Today's most common antidepressants target the brain's serotonin or noradrenaline pathways (some target both). Ketamine acts on the NMDA receptor, a component of the glutamate pathway, which is involved in memory and cognition. Before ketamine was studied, no one even knew that the pathway was involved in depression, Murrough says.

In 2013, his group published the largest trial of off-label ketamine carried out so far, with 73 participants. The trial found that the drug reduced depression 24 hours after treatment in 64% of patients who had tried three or more other medications with unsuccessful results. A second group received the sedative midazolam; in that case, the reduction was 28% (J. W. Murrough *et al. Am. J. Psychiatry* **170**, 1134–1142; 2013). Murrough's group is now imaging the brains of patients receiving ketamine treatment to try to dissect just how the drug works.

Murrough says that long-term studies of the