For the new Secretary of the Interior, Mr Hickel, the disaster could not have come at a worse time. He looks like being the first of the new cabinet officers to have to run the gauntlet of public criticism. He was, of course, accused of being a tool of the oil industry lobby when his nomination was challenged, and his decision to ask for a voluntary cessation of drilling from the other companies working in the Santa Barbara channel, and then, a day later, to allow drilling to restart, was particularly maladroit. But Mr Hickel has now initiated a review of the fifteen year old drilling regulations which were primarily designed to deal with the conditions encountered in the gulf coasts of Texas and Louisiana. President Nixon seems to have anticipated the outcome of the inquiry by saying at a press conference that "We've got to get to the source of the problem" and "that means very stringent regulations in off-shore drilling". Congress may be more inclined to pass proposals—which it balked at last year—for strengthening Federal control of pollution from drillings and tankers. Future drilling regulations will probably include some of the practices which companies still working in the Santa Barbara Channel have voluntarily but belatedly adopted. These include more frequent testing of safety devices to prevent blowouts, increased use of drilling mud to seal nascent fissures and installation of stronger well casings.

But how does a well blowing wild cause the sea bed to crack? It is too soon yet to know exactly what happened at Santa Barbara, but the pattern of events suggests that, to begin with, something went wrong at the base of the well. Once this happens, the pressure builds up and oil begins to escape either up the casing of the well or outside it, or into the strata above the reservoir. In either event it can cut fissures into the sea bed as it emerges. Once this has happened, the only cure is to drill a new hole into the reservoir starting perhaps half a mile from the well but with a sloping bore so that it ends up close to the well. Once the second boring penetrates the reservoir, any material heavier than the oil from the well can be pumped into the reservoir. This in effect strangulates the well by counteracting the pressure forcing the oil out of the oil-bearing rock. Union Oil has apparently adopted this procedure, and, now it has sealed it, it has the option of repairing the well or filling it up with concrete and giving it up as a bad job. The betting is that it will do the latter.

EARTH SATELLITES

Prospecting from Above

from our Astronomy Correspondent

NON-STICK frying pans used to be the spin-off which made space research worthwhile. The latest claimants are called earth resources satellites which, the arguments go, will lead to massive benefits in cartography, agriculture, oceanography, geology and hydrology simply by using space platforms as vantage points for looking at the Earth. The latest document to back earth resources satellites is a report prepared for a subcommittee of the House Committee on Science and Astronautics. In his introduction, Rep. Joseph E. Karth, chairman of the Subcommittee on Space Science and Applications, says that an earth resources satellite system represents the largest potential return on investment of any space project so far. He goes on to recall how last year the subcommittee unsuccessfully tried to double NASA's modest budget for an earth resources satellite. Since then the subcommittee has kept more than a watchful eye on the project, and much of the report is a criticism of what has happened.

The report makes few concessions to the scepticism which many scientists share about earth resources satellites, however. Yet there is widespread doubt whether instrumentation has reached a stage advanced enough for a valuable earth resources programme. Prospecting for minerals, for example, put forward as a job which satellites ought to be doing, requires measurements which are hard enough to carry out from an aircraft flying at 1,000 feet, let alone from a satellite at 100 miles. And the proponents of simple geological mapping from space photographs cannot so far point to any new geological features revealed from satellite photographs. Naturally enough, much of the value of viewing the Earth from space depends on the detail which can be seen, and it is here that much of the controversy lies. The claim that Gemini photographs frequently contain greater detail than conventional aerial photographs is hard to believe, but high resolution photo-reconnaissance systems from military satellites could make geographical mapping from space a possibility. But will it be economically worthwhile? And will it ever be possible, let alone economic, to conduct land-use survey by satellite? Then the application of satellites to oceanography and hydrology, mentioned in the report, requires sensors in ranges other than the visible in many cases. The use of radar to detect the roughness of the sea, and infrared sensors to detect ocean currents where there may be schools of fish, are just two examples. Here it is more than likely that the development of the necessary instrumentation is at too early a stage to warrant the support for earth resources satellites for which the report asks. And in spite of the dispute which is reported to have blown up last year over the release of several hundreds of Apollo 7 photographs—only thirteen pictures were cleared for publication in the first week after the flight—there is no hard evidence that the photographers on Apollo 7 were able to bring back information about the surface of the Earth not otherwise available. To be sure, if it had not been for Columbus, the astronauts would have discovered the New World, but that is not what the present excitement is about.

Much of the congressional report is a history of what amounts to a tug-of-war between NASA and several other agencies, chiefly the Departments of the Interior and Agriculture. According to the subcommittee, while NASA has consistently lacked enthusiasm for earth resources satellites, the Interior and Agriculture Departments have been prodding for more action. Much of the discussion has centred around whether the sort of spacecraft envisaged by the Interior Department is or is not beyond the state of the art. "Just at or just beyond the current state of the art", according to NASA, but "currently within the state of the art" according to a committee set up at the direction of the Secretary of the Interior. For years—since 1964—NASA has considered earth resources projects as part of the manned space flight programme, to the dismay of critics who want to see much cheaper unmanned systems. But even since 1967, when the

study of what is called an Earth Resources Technology Satellite (ERTS) was assigned to NASA's Goddard Space Flight Center, the criticism of NASA has continued, chiefly on the count of foot-dragging. Lack of push in asking for money for ERTS, a symptom of NASA's disaffection with the project, last year resulted in the House Science and Astronautics Committee recommending an increase in funding. The indications are that NASA is sensible enough not to take the criticisms of the report too much to heart and rush into projects whose worth, to say the least of it, is far from proved. NASA's line, which is to continue aircraft experiments to see just what information satellites can pick up, and how valuable it is likely to be, is the right approach. After all, this bullish report itself says that a determination of cost effectiveness is not yet possible—without such an analysis it would be foolish to go on.

GEOPHYSICS

Foreign Aid

from a Correspondent

AFTER two years of deliberation, the US National Academy of Sciences has finally announced what it will do with the $1 million estate bequeathed to it in 1966 by Arthur L. Day. Dr Day, a geochemist and former director of the Geophysical Laboratory of the Carnegie Institution of Washington (1907–36), stipulated that the income from the estate should be used "for the purpose of advancing the studies of the physics of the Earth". A large part of it will thus be used to establish a grant programme (to be known, somewhat ponderously, as the Arthur L. Day Projects in Foreign Cooperative Geophysics) to aid foreign collaborators of American geophysicists, though some will go to the founding of a bi-annual geophysics lecture series and the balance to partially support a new geophysics conference room at the academy's Washington headquarters.

In creating the grant programme, the academy has recognized the importance of global coordination in geophysics. Apparently, some American scientists have also been speaking up for research workers and their budgetary problems in areas where geophysical studies are less than successful. Although no country is specifically excluded, the academy clearly has in mind the so-called underdeveloped nations as recipients rather than the relatively well-off western European nations. The basic idea is not to give full support to the foreign scientists in question, but rather to add a little financial lubrication to critical projects which are failing to realize their full potential.

American support for foreign geophysics is not, of course, a new departure. The International Geophysical Year of 1957–58 represented global cooperation *par excellence*, though since that time the United States has sponsored bilateral projects—notably the US–Japan Cooperative Program of the early 1960s. However, the latter was financed largely by the National Science Foundation. With US governmental support for even the most innocuous of foreign scientific projects frequently being grossly misrepresented by student revolutionaries and others, it is perhaps as well that the latest attempt to foster cooperation is in the hands of an autonomous, non-governmental institution.

DESALINATION

Water for the South-West

WHERE desalination plants are concerned, there is plenty on paper, very little on the ground. Every so often a new plan emerges—bigger, better and more expensive than the last—and the fact that few plants have so far been built does not yet seem to have put a damper on optimism. Two major projects, for an agro-industrial complex in the Middle East, and for a power and water complex at Bolsa Island in California, are on ice; but last month another plan, which would provide water for Southern California, was published by the IAEA, the United States AEC and the Mexican Government, which were the three sponsors. The report, *Nuclear Power and Water Desalting Plants for Southwest United States and Northwest Mexico*, costs $3.

The survey team seems to have satisfied itself that the plant is technically feasible, although a further study of the economics of the system is necessary. The plant would produce a thousand million gallons of fresh water a day, in addition to a gross power capacity of 2,000 MWe. It would take 9 or 10 years to build, after the decision to go ahead had been made, and would cost somewhere between $850 and $1,000 million if it were built at the cheapest site. Other possible sites would increase the total cost by $250 million; annual running costs would be around $80 to $180 million a year, and the cost of the fresh water produced would be between 15·5 and 40 cents per 1,000 gallons, depending on the interest rates and the site chosen. Power would sell at between 1·8 mills per KWh and 3·1 mills per KWh, although for more advanced plants, using breeder reactors, a reduction of 0·5 mills per KWh could be expected.

The study assumed that the reactor used would be of the light water type, and that two would be used. The desalination plant, using the flash distillation principle, would consist of four trains, each capable of producing 250 million gallons of water a day; the total plant would be 900 feet long and 1,900 feet wide. Evidently, with a plant this big, one of the problems is devising ways of marketing the power and the water produced, and the report deals with these problems too. It points out that the area concerned is a semi-tropical desert region, in which underground water reserves are being depleted and the water quality is declining at an accelerated rate. The water deficit for the region, the report estimates, will be 1,300 million gallons per day by 1980, and 2,500 million gallons a day by 1985. It also seems that the power from the plant could be absorbed, 600 MWe of it on the Mexican side of the border, and 1,100 MWe on the United States side. (The other 300 MWe is used up inside the plant.)

Three sites were selected as the best available; they are at El Golfo de Santa Clara, Riito and San Luis Rio, Colorado. The report collects together a large amount of relevant information about the sites, including the possibility of cyclones or earthquakes; but it adds that more information about problems like these will be needed before a decision can be taken. It also recommends that further engineering and economic studies should be made, including an examination of the impact on regional development of the building of the plant. Even if these are favourable, however, these seems to be a long way to go before the people of the area have enough water.