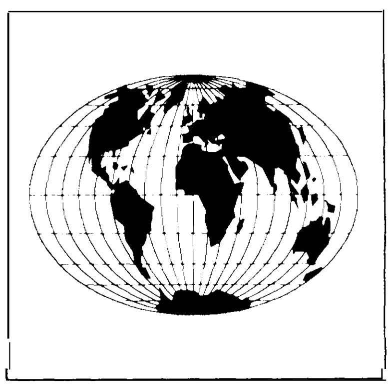
International Cooperation and Competition 8

The European Space Agency (ESA) and the governments of China, France, India, Japan, and Russia each operate remote sensing systems to study Earth's surface.[1] Canada will join this group in 1995 when it launches Radarsat, a system optimized to monitor ice conditions, especially in the northern hemisphere. Europe, Japan, and Russia operate satellite systems designed to gather weather and climate data. In many cases, data from these systems complement U.S. data. In others, they overlap them. The many non-U.S. remote sensing systems either planned or in operation raise concerns of competition and cooperation for the United States. Until recently, the United States led the world in all areas of remote sensing from space. Now other countries compete with the United States for the small but growing commercial market in remotely sensed data. For example, SPOT Image, S.A., has been selling data from the French SPOT satellite since 1987. Other countries also compete with the United States for scientific and technological kudos.



INCREASED INTERNATIONAL COOPERATION IN EARTH MONITORING AND GLOBAL CHANGE RESEARCH

The experience of Canada, ESA, France, Japan, and Russia with remote sensing technology and data handling suggests that they would make effective partners in cooperative satellite and data programs. Indeed, as noted earlier in this report, the United States plays an active part in cooperative activities to gather and distribute meteorological data (box 8-A). It also cooperates

[1] See app. D for a summary of each country's remote sensing activities.

Box 8-A-international Cooperation in Weather Monitoring

International cooperation in meteorological satellites has a long, successful history.[1] The U.N. World Meteorological Organization (WMO), founded in 1951, can trace its roots to the International Meteorological Organization, which was established in 1853. The WMO is a planning and coordinating body with basic programs to help all countries cooperatively produce and obtain important meteorological data.

Extensive cooperation is evident between the United States and many European countries. As noted, the United States has excellent working relations with Eumetsat and now relies on a Eumetsat weather satellite to augment coverage of the remaining geostationary operational environmental satellites (GOES) platform; the United States had previously made excess GOES weather monitoring capability available to Europe.

Although international cooperation can reduce costs to each party, there are limits on the extent of cooperation that infeasible. For example, weather patterns and the nature of severe storms in the United States are different than those of Europe. In the future, U.S. meteorologists are interested in obtaining simultaneous images and soundings, a capability that will provide better warning of relatively small, violent storms, such as tornados. Because the conditions that might produce small, extremely severe storms are very seldom present in Europe, Eumetsat accords lower priority to simultaneous imaging and sounding in its geostationary satellite system.

1 See appendix D for a more detailed description of international cooperation in weather monitoring and other remote sensing activities.

extensively with Europe on the National Oceanic and Atmospheric Administration's (NOAA) polar orbiting satellite system, and both Europe and Japan have important roles in National Aeronautics and Space Administration's (NASA) Earth Observing System (EOS) program. In addition, the United States has worked closely with Canada on the development of Radarsat. NOAA and NASA have sought cooperative arrangements in order to reduce their program costs, but also to tap the considerable scientific and engineering expertise available in Japan and Europe. U.S. partners have similar motivations with respect to the United States.

The United States participates in the Committee on Earth Observation Systems (CEOS), created in 1984,[2] which coordinates existing and planned satellite Earth observations,[3] and in the International Earth Observing System (IEOS), which NASA organized to coordinate the work of the international partners in EOS. In other words, these cooperative arrangements provide benefits consistent with U.S. space policy:

> The United States will conduct international cooperative space-related activities that are expected to achieve sufficient scientific, political, economic, or national security benefits for the nation.[4]

The success of these cooperative efforts and the desire to make greater use of shared scientific and technical resources, combined with the need to find more efficient, cost-effective ways of gathering global environmental data have led to numer-

Z CEOS developed out of discussions begun in 1982 at the June meeting of the Economic Summit of Industrialized Nations in which a working Group on Technology, Growth and Employment discussed cooperative efforts in satellite remote sensing. An international Panel of Experts on Remote Sensing from Space, chaired by the United States, established CEOS in 1984,

3 D. Brent Smith, "International Coordination of Earth Observation From Space Activities. ' Paper presented at the Twenty-Third International Symposium on Remote Sensing of Environment, Bangkok, Thailand, Apr. 18-25, 1990.

4 The White House, *National Space Policy, Nov. 2, 1989,* p. 2.

ous suggestions for closer international cooperation in environmental remote sensing.[5] Such suggestions are consonant with more general interest in enhanced international cooperation.

The end of the Cold War and the continued growth of scientific and technical competence overseas makes such cooperative arrangements much more feasible than before. Indeed, several recent reports have urged greater international cooperation in space activities than previously experienced.[6] However, the perceptions, habits, and institutions developed by the world during the height of the Cold War will not change quickly. In addition, as several recent reports of the Carnegie Commission on Science, Technology, and Government have noted, U.S. science and technology institutions need to be improved in order to foster more effective international collaboration.[7]

INTERNATIONAL COOPERATION AND SURFACE REMOTE SENSING

Several authors have suggested that the United States should approach other countries about establishing a cooperative program in surface remote sensing.[8] Because both commercial considerations and government prestige and control **are** involved in the provision of remotely sensed surface data, the issue of cooperation is more complicated than with strictly government-government cooperative arrangements, or with strictly commercial cooperative ventures. On the one hand, satellite system costs often exceed one-half billion dollars for a single satellite and its associated ground systems.[9] On the other, the existence of several systems, each generating data of somewhat different characteristics and quality, gives data purchasers a greater variety of data sources from which to choose. Yet, as a result of the high system and operations costs, data prices remain high even though they are still highly subsidized. In order **to limit** unnecessary **re**dundancy by governments, reduce **costs,** and **to** promote more effective application of the data for a wide variety of data **users, the United States may wish to explore the potential for working with other countries in a cooperative venture in surface remote sensing.**

The existing governmental and commercial structures for multispectral land remote sensing provide a specific example of how difficult such cooperation might be to arrange. For example, the French firm SPOT Image, S.A. sells data from the French SPOT satellite in competition with the U.S. company Earth Observation Satellite Co. (EOSAT), which markets data from the U.S. Landsat satellite. In both cases, the governments

[5] John H. McElroy, ''Intelsat, Inmarsat, and CEOS: Is Envirosat Next?" Presented at the American Institute for Aeronautics and Astronautics Workshop on International Space Cooperation: Learning from the Past, Planning for the Future, Hawaii, December 1992; D. Brent Smith, Linda V. Moodie, Betty A. Howard, Lisa R. Schaffer, and Peter Backlund, "Coordinating Earth Observations from Space: Toward a Global Earth Observing System" (IAF-9(L1OO). Presented at the 41st Congress of the International Astronautical Federation October 1990, Dresden.

[6] U.S.-Crest, *Partners in Space* (Arlington, VA: U. S.-Crest, May 1993); Vice President's Space Policy Advisory Board, *A Post Cold War Assessment of U.S. Space Policy* (Washington DC: The White House, December 1992), pp. 33-38; Space Policy Institute and Association of Space Explorers, "International Cooperation in Space-New Opportunities, New Approaches: An Assessment," *Space Policy*, vol. **8,** No. **3,** August 1992, pp. 195-204.

[7] Carnegie Commission on Science Technology, and Government, Science *and Technology in U.S. International Affairs (New* York, NY: Carnegie Commission January 1992); Carnegie Commission on Science Technology, and Government *International Environmental Research and Development Research and Assessment: Proposals forgetter Organization and Decision Making* (New York, NY: Carnegie Commission, July 1992).

[8] Neil R. Helm and Burton 1. Edelson, ''An International Organization for Remote Sensing' (IAF-91-1 12). Paper presented at the 42nd Congress of the International Astronautical Federation October 1991, Montreal, Canada; John L. McLucas and Paul M. Maughan, ' 'The Case for Envirosat,'' *Space Policy, vol. 4, No. 3,* August 1988, pp. 229-239.

[9] DOD and NASA estimate that for Landsat 7, acquisition and operations costs over 5 years of operation will total over a billion dollars. See ch. 4.

paid for and launched the satellites. Until the Russian Almaz satellite, which carried a synthetic aperture radar (SAR), failed in October 1992, a Russian government corporation was marketing data from the government-owned and operated satellite.[10]"

Such a cooperative venture might be tried with a system for which the commercial data markets are less well developed. For example, the United States could seek to institute a cooperative development program for a SAR system, to be used not only for global change research, but also for supporting development and resource management projects, and for a wide variety of commercial uses. The U.S. SAR, which NASA had planned to build as part of its EOS, would have been a highly sophisticated and expensive, multifrequency, multipolarization system.[11] Because of the cost and technical risk involved, NASA deferred development of its EOS SAR. However, because several other countries also have experience in building SAR instruments, it might be possible to construct an effective multifrequency, multipolarization SAR system in partnership with other countries. One way to do this and keep the technical and managerial interfaces relatively uncomplicated would be for each organization involved to build its own SAR satellite designed to operate at a frequency different from the others.[12] Each satelleite could also be designed to operate aeat several polarizations.[13] If flown in adjacent orbits, these satellites would operate much like a multifrequency, multipolarization SAR on a single platform, but the cost and technical risk of each satellite would be less than for the single platform.

Under this arrangement, partners from different countries or space organizations could each contribute different space instruments, satellite platforms, or receiving systems in return for favorable data prices. Each partner could still develop expertise in several different areas, cooperating where expertise did not overlap, competing where it did. Because the scale of the investment would be so large as to require major funding from governments, who would also be the venture's primary customers, it might be possible to structure the project initially under the aegis of CEOS. If the system were technically successful, it might eventually be advantageous to house it in a more permanent administrative structure.[14]

MAINTAINING A U.S. COMPETITIVE POSITION IN REMOTE SENSING

The U.S. desire to maintain a strong U.S. position in high technology products in order to contribute to its economic competitiveness and reach a more favorable balance of international trade raises the question of how the United States can bolster its technological advantage and improve its competitive market position in remote sensing technology and data products. Especially with the projected reductions in spending for defense-related technologies, the United States is disadvantaged abroad by its existing policies of generally maintaining an arms-length relationship between the government and private indus-

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10 With a resolution as fine as 7 meters, this satellite was a powerful tool for generating maps of the Earth's surface and for observing changes, despite intervening cloud cover. In the United States, Almaz data were distributed first by Space Commerce Corp., and more recently by Hughes STX Corp. For a variety of reasons, including uncertain data delivery, sales have been limited.

11 NASA estimates place the cows of the NASA plan at about $1.5 billion. See app. B for a detailed description of SAR technology.

12 JPL SAR program officials, who originated this concept, suggest that three bands would be appropriate--C band, L band, and X band.

13 Different polarizations provide different views of Earth's surface, depending on the material sensed. Multiple polarizations on the same instrument provide substantial additional data for analyzing surface conditions.

14 McElroy, op. cit., footnote 5.

try. Other countries, most notably Canada and France,[15] have aggressively pursued the development of remote sensing satellite systems to monitor the land surface and oceans in concert with their private sector.[16]

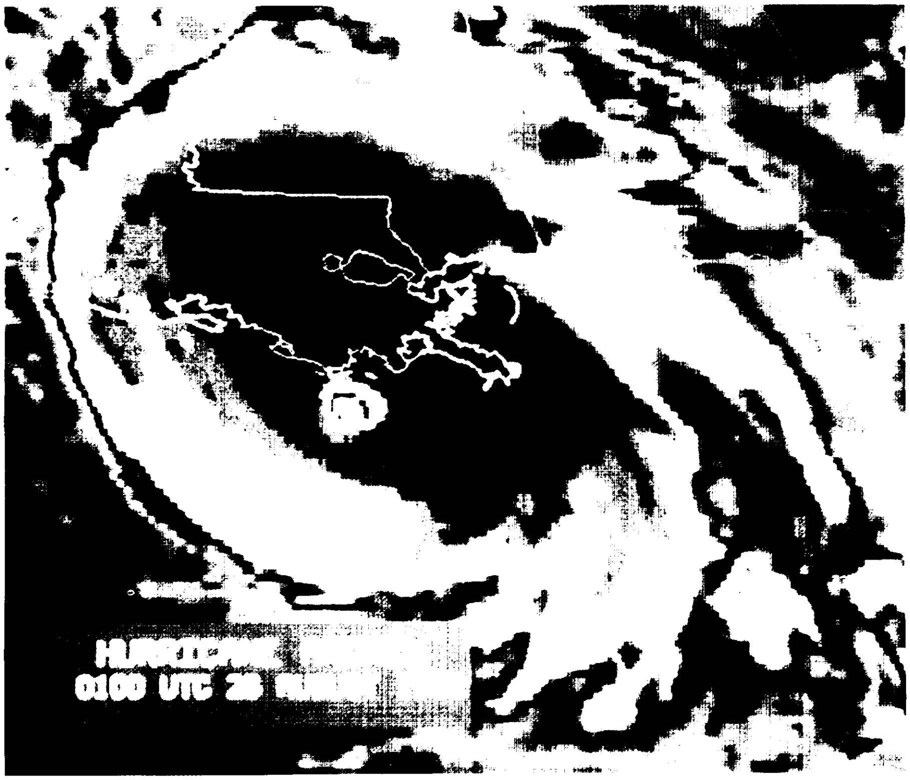
In order to maintain and enhance U.S. capabilities in civilian remote sensing, the United States **may need to develop new forms of partnership between government and the private sector. Otherwise, the United States could be left behind in the race to develop new remote sensing technologies. In** particular, the previous chapter suggested that the U.S. government could undertake R&D programs to foster innovation in the development of sensors and satellite systems within the U.S. private sector and move toward purchases of data rather than satellite systems from the private sector.

The final report of this assessment will examine the benefits and drawbacks of international cooperative mechanisms in much more detail in the context of a strategic plan for U.S. remote sensing activities. In particular, it will explore issues such as:

- institutional models for international cooperation in remote sensing;
- the roles of U.S. agencies, including NASA, NOAA, Department of Defense, and the Department of State;
- the United States as a cooperative partner: successes and failures; and
- the appropriate balance between cooperative and competitive activities.

15 R~~~ has also developed private companies to market remotely sensed ~@ with mixed 'Salts

16 When it contracted with EOSAT to market data from the Landsat series of satellites, the United States also developed a new public/private institution. However, ambivalence within the U.S. Government toward the arrangement made it extremely difficult to follow through with the arrangement.



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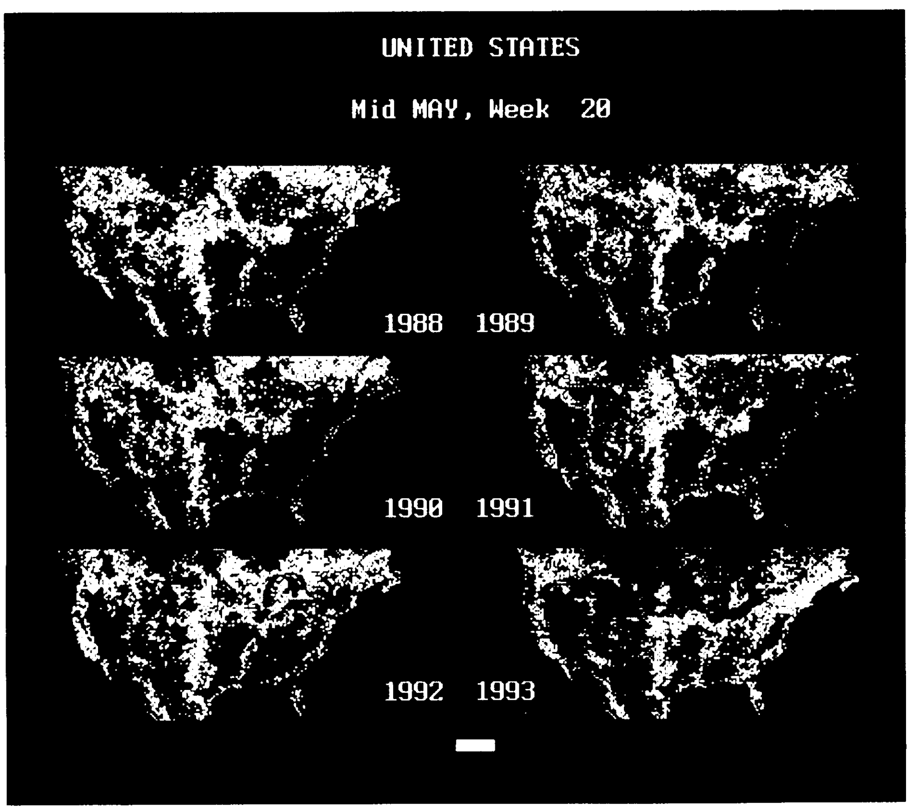

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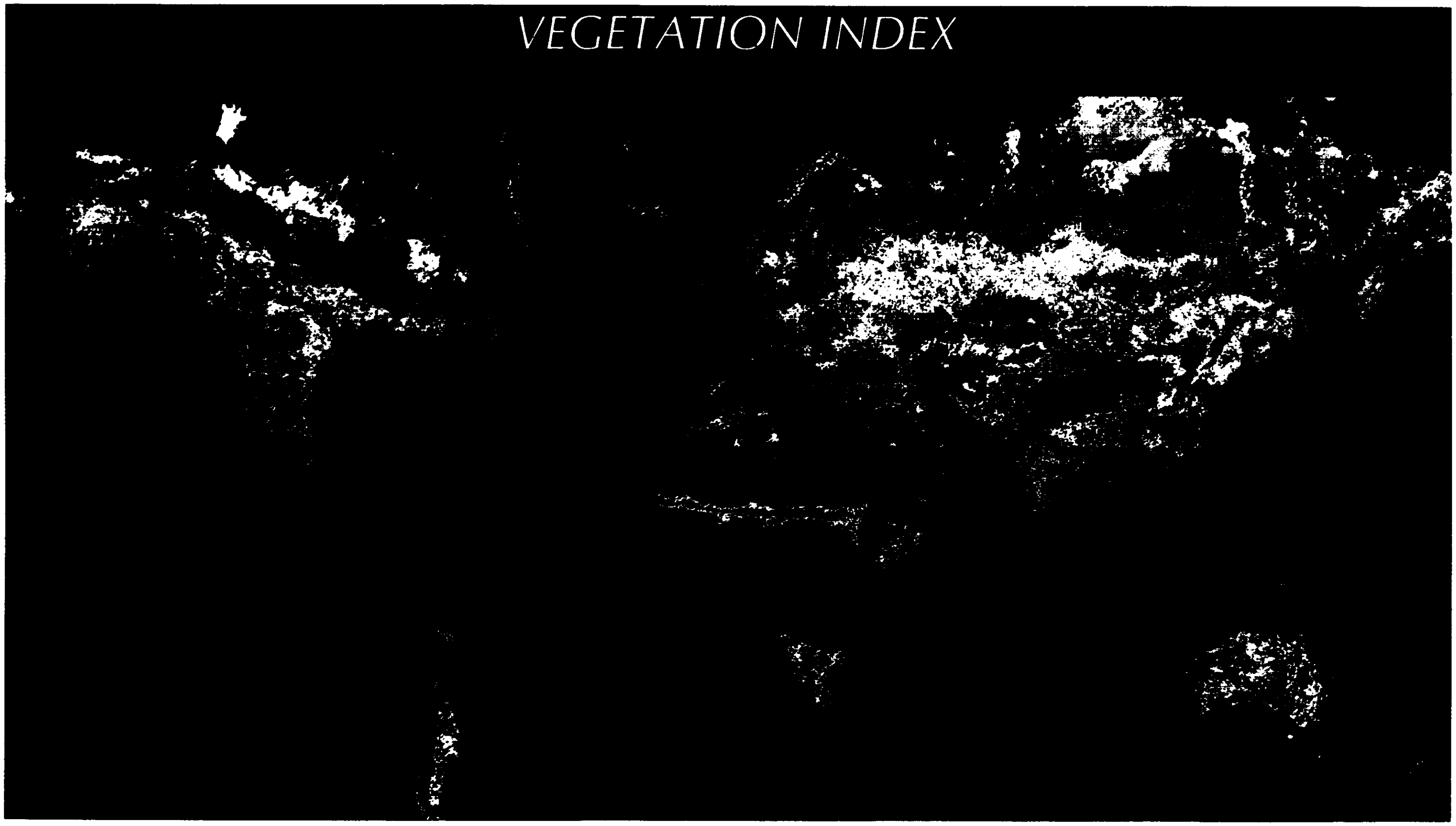

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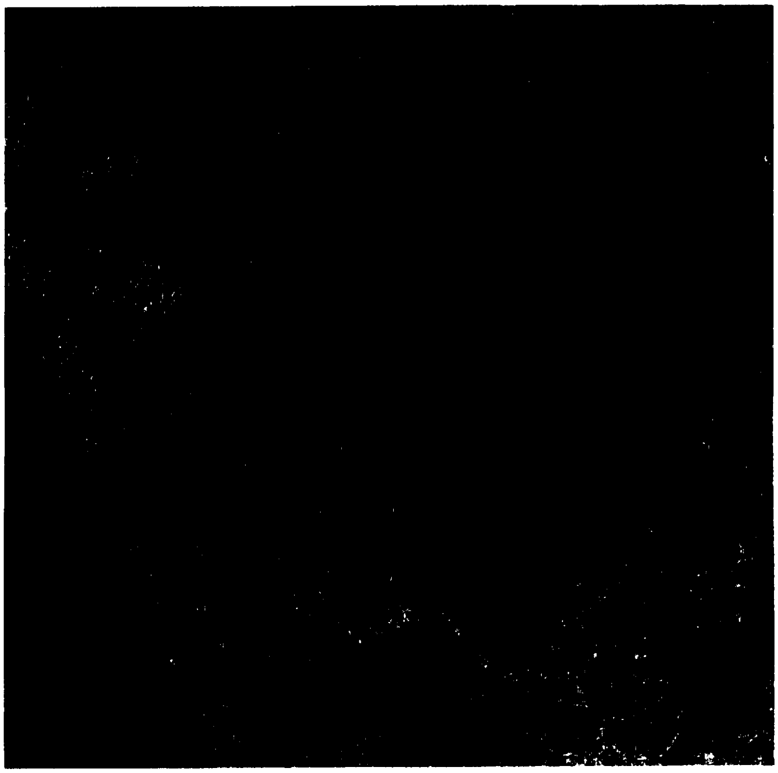

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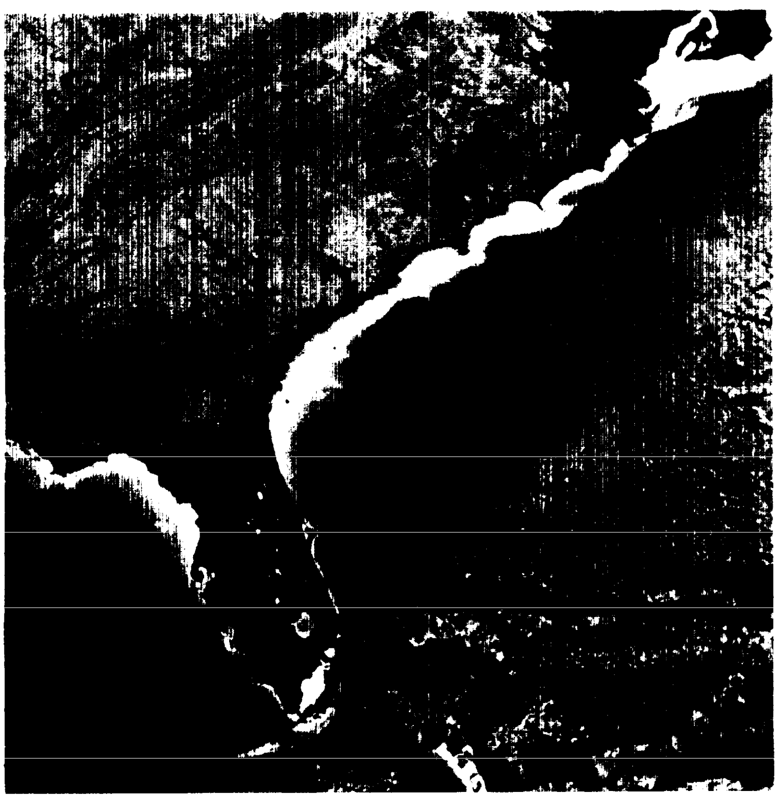

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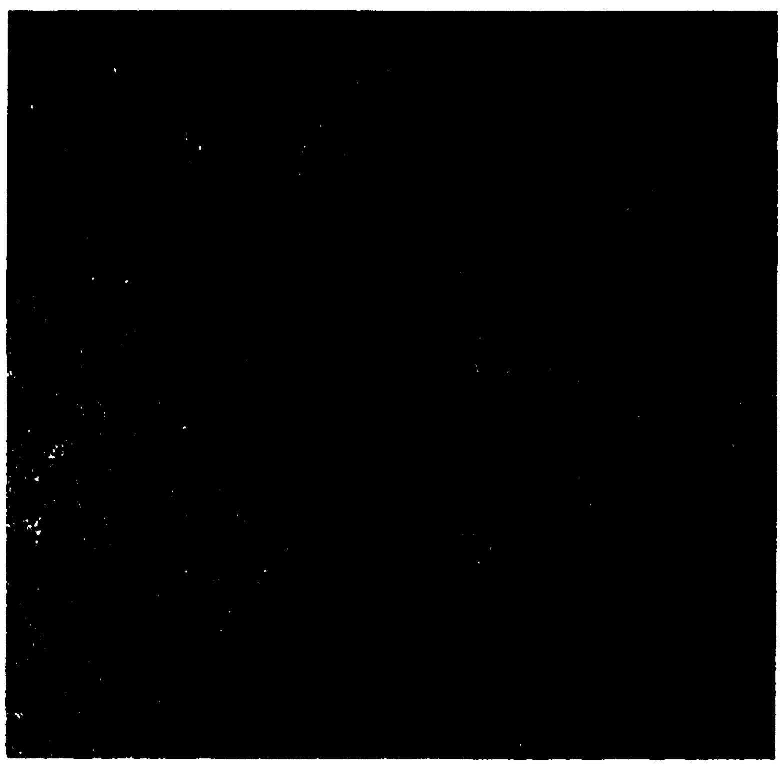

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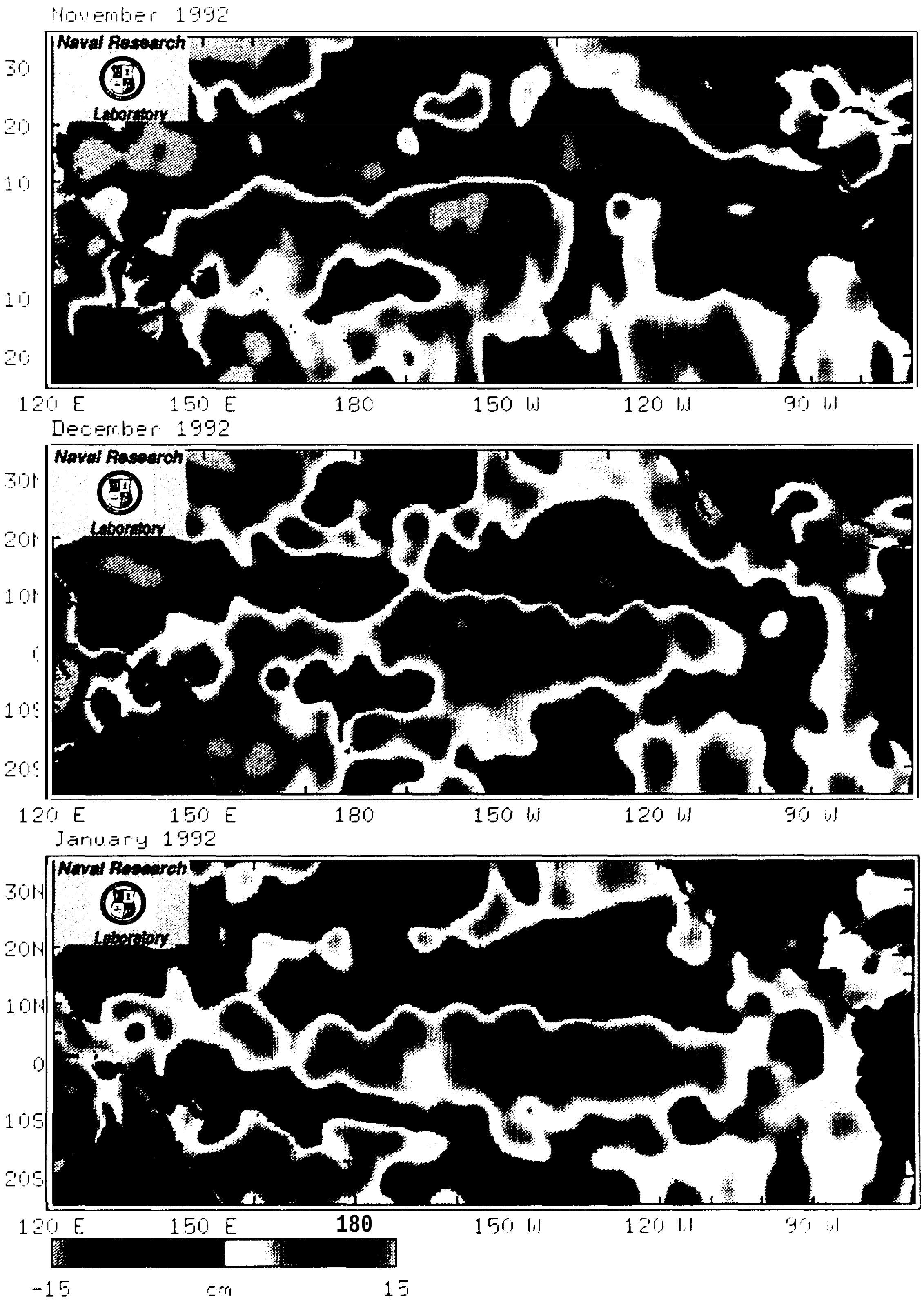
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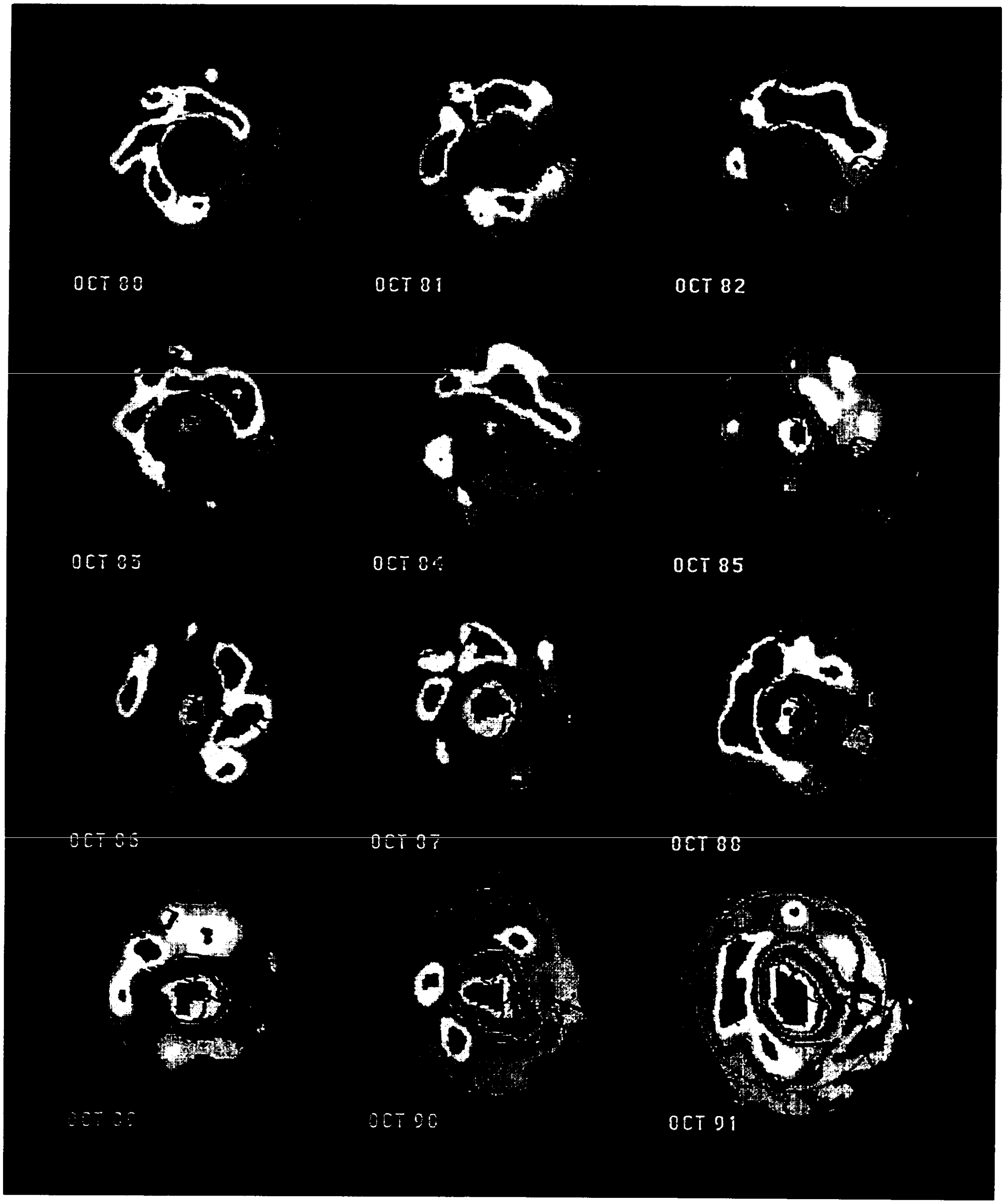
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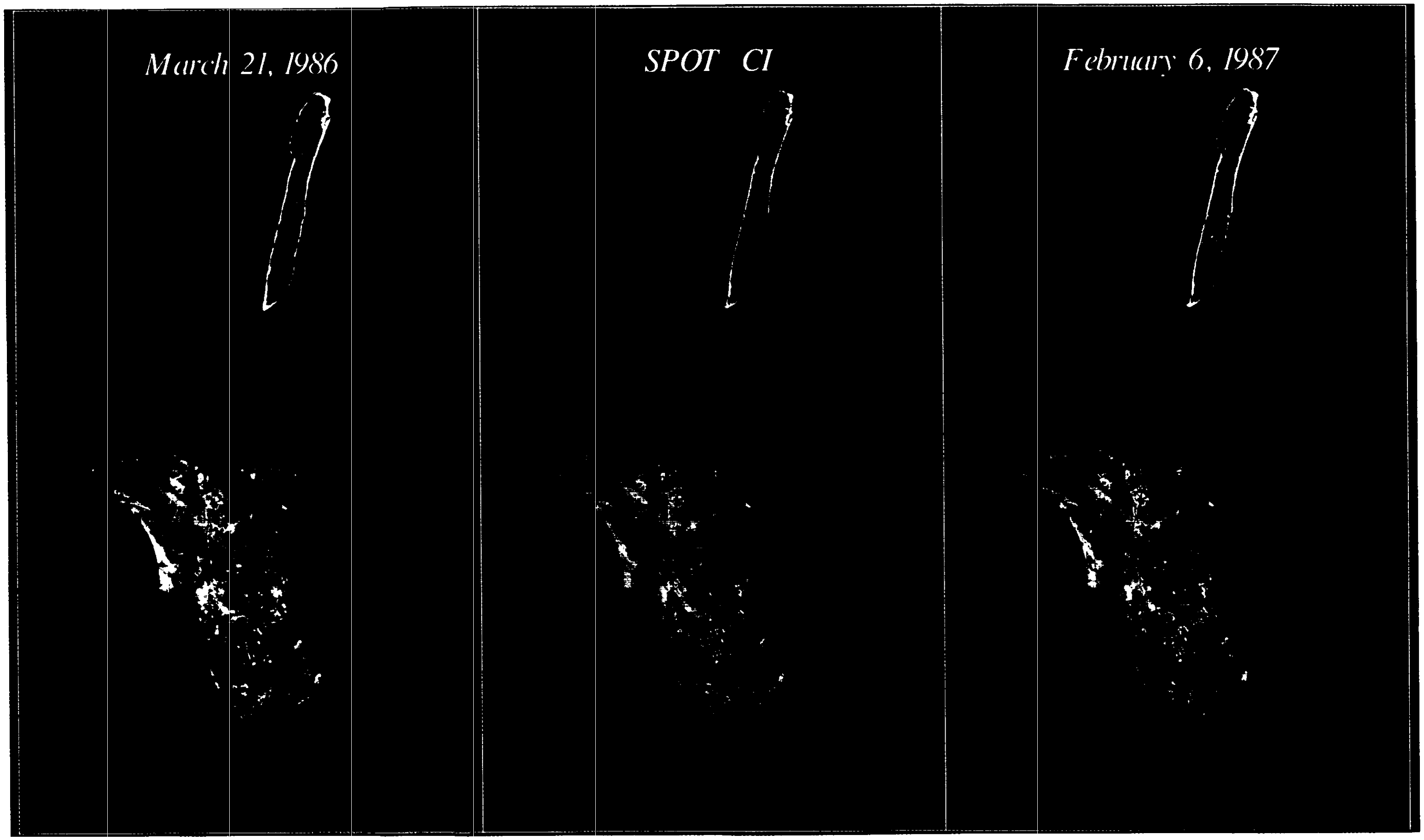

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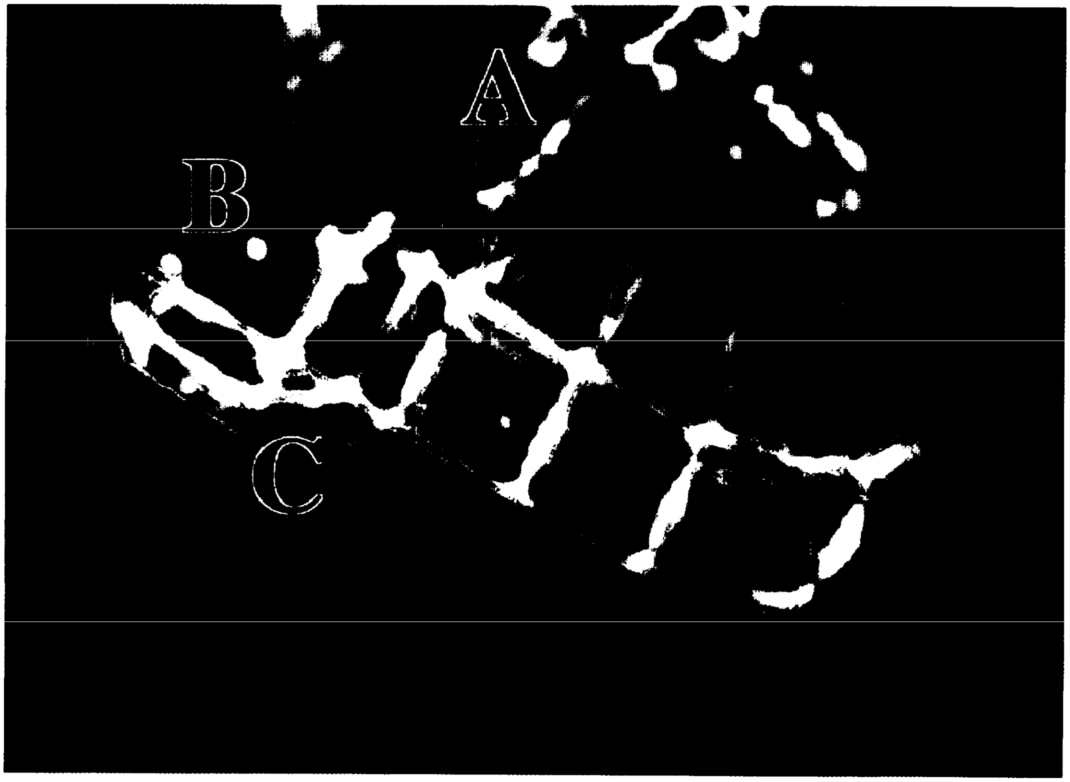

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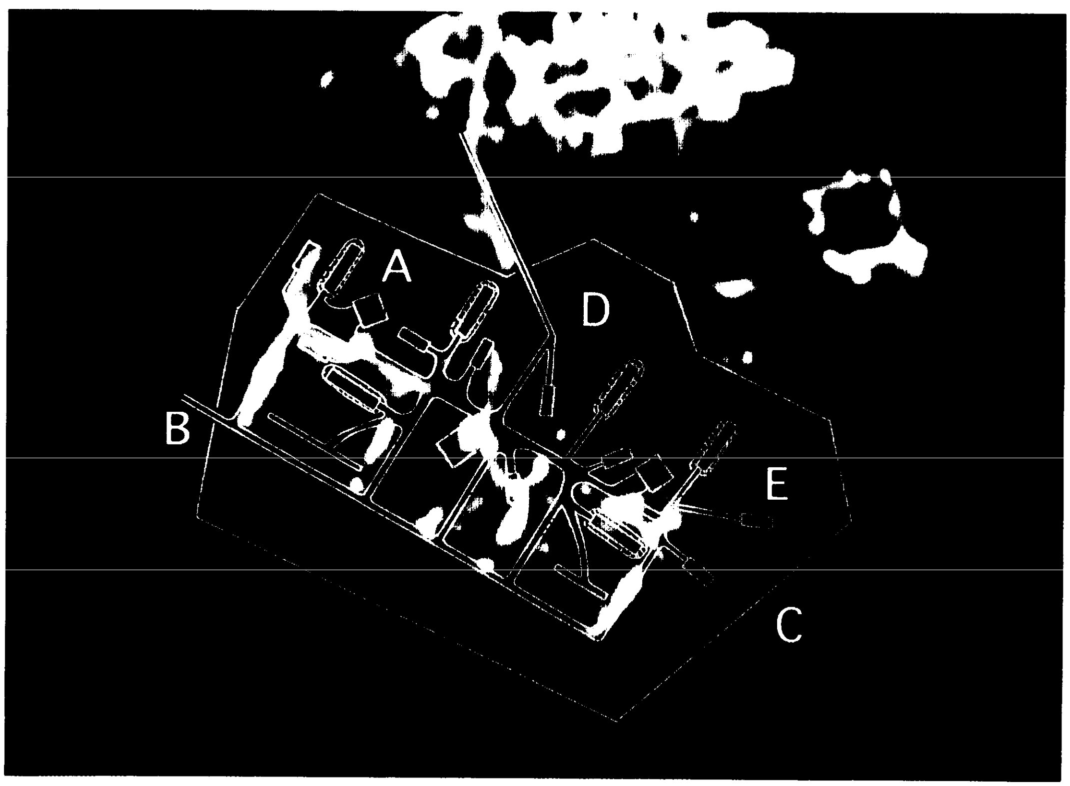

PLATE 12