

# RESEARCH COOPERATION BETWEEN THE NATIONAL SPACE DEVELOPMENT AGENCY OF JAPAN (NASDA) AND PETROBRAS FOR MONITORING A TROPICAL RAIN FOREST ENVIRONMENT USING JERS-1 SAR DATA: PRELIMINARY RESULTS OF GEOLOGIC STUDIES

FERNANDO PELLON DE MIRANDA<sup>1</sup>  
CRISTINA MARIA BENTZ<sup>1</sup>  
LUCIANO EMÍDIO NEVES DA FONSECA<sup>1</sup>  
RAIMUNDO ALMEIDA FILHO<sup>2</sup>

<sup>1</sup> PETROBRAS/CENPES - Centro de Pesquisas Leopoldo A. Miguez de Mello  
Cidade Universitária, Quadra 7 - Ilha do Fundão Cep 21.949-900 Rio de Janeiro, RJ, Brasil  
{fmiranda, cris, lenf}@cenpes.petrobras.gov.br

<sup>2</sup> INPE-Instituto Nacional de Pesquisas Espaciais  
Caixa Postal 515, Cep 12.227-970, São José dos Campos, SP, Brasil  
rai@ltid.inpe.br

**Keywords:** JERS-1 SAR, petroleum exploration.

The exploration of Brazil's sedimentary basins is a permanent challenge. The prospected areas are immense; large portions of them are submerged, covered by dense forests, or present specific geologic problems. The success of efforts to increase oil and gas reserves depends on the efficiency of geologists and geophysicists, state-of-the-art equipment, and the utilization of updated techniques. With the utilization of the JERS-1 SAR data, the PETROBRAS R&D Center (CENPES) will be able to develop innovative research projects, opening up new perspectives to support exploration activities in Brazil's sedimentary basins.

A technical and scientific cooperation agreement signed between the CENPES and the National Space Development Agency of Japan (NASDA) opens up new technological frontiers for Brazil in the field of digital images obtained via satellite for use in the study of nonrenewable mineral and energy resources. Signed on February 2 of this year, this agreement meets one of the objectives of PETROBRAS - to introduce the latest - generation remote sensing technology to support petroleum exploration and production activities, as well as environmental protection efforts by the Company.

The digital data used in the research are generated by the Japanese Earth Resources Satellite-1 (JERS-1), which is equipped with two advanced remote sensing systems - Optical Sensor (OPS) and Synthetic Aperture Radar (SAR) - that can be used in various geoscientific fields and in the observation of man-made features. The JERS-1 satellite (1,340 kilograms) was launched from the NASDA space center on Tanegashima Island in February 1992, transported in a H-I launch vehicle, a

two-stage rocket. Its orbit around the Earth, at an altitude of approximately 568 kilometers in an approximately north-south direction, brings it near the poles, crossing the Equator at 10:45a.m. The duration of each orbit is 96 minutes, completing 15 rotations per day. It covers the entire Earth's surface except the polar regions in 44 days, slightly shifting its course on each pass. It returns to the same course at the end of each 44-day period, passing over the same points exactly at the same time of the day. So that, it produces successive records of the same land surface area. Each imaged area covers a strip of land 75 km wide.

The JERS-1 SAR is a radar system which operates on the L Band (23 cm), a wavelength appropriate for studies in areas covered by dense forests due to its effective penetration of heavy plant cover. Furthermore, as the radar beam is not affected by clouds, JERS-1 SAR images can be acquired even in adverse tropical climatic conditions. The OPS system is used to identify types of rocks and minerals, but it is weather-dependent.

The agreement with NASDA dates back to April 1992, when President Masato Yamano led a group of Japanese experts visiting CENPES. The objective of this agreement is to establish a framework for research cooperation for monitoring of a tropical rain forest environment by using JERS-1 SAR data. Research cooperation is broken down into component research projects listed below: a) JERS-1 SAR calibration by natural forest; b) JERS-1 SAR calibration by corner reflectors; c) geologic study of a tropical rain forest environment by JERS-1 SAR data; d) application of

JERS-1 SAR for biomass estimation in deforested areas; e) vegetation mapping and detection of seasonal changes in Central Amazon by using JERS-1 SAR data; f) JERS-1 SAR images applied to two sites under long-term intensive ecological study in Central Amazon. Also participating in the projects are representatives from Brazil's National Space Research Institute (INPE) and from the National Amazon Research Institute (INPA), Brazilian government agencies that carry out studies in this region.

The area being studied under research item (c) lies close to Manaus, capital of the State of Amazonas. It covers an area of approximately 20,000 km<sup>2</sup> (110 km by 183 km) and is bounded by latitudes 3°00' and 2°00'S and longitudes 60°10' and 58°30'W. This area has been selected because of the large collection of available geological and geophysical data, the experience of CENPES in working with digital data integration using Geographic Information Systems (GIS), and the availability of the PETROBRAS logistics infrastructure.

The project focuses on digital data integration within a GIS environment. Mapping of geologic structures will rely mostly on digital merging of JERS-1 SAR, geologic, topographic and aeromagnetic data. JERS-1 SAR images of the investigated site were acquired on 30 Sep. 1993 (Path 413 - Row 304, Path 413 - Row 305), 1 Oct. 1993 (Path 414 - Row 304, Path 414 - Row 305, Path 414 - Row 306) and 12 Nov. 1993 (Path 412 - Row 304, Path 412 - Row 305). Data processing procedures applied to each JERS-1 SAR scene include adaptive filtering to speckle removal and histogram manipulation. A geometrically corrected mosaic is obtained with histogram normalization among images.

Data integration (e.g., geologic and topographic maps, JERS-1 SAR mosaic) has been done using image processing techniques such as IHS combinations, pseudo-stereoscopic visualizations and 3-D perspective views. The objective is to highlight morphologic features related to neotectonic activity in the area. Such tectonism is expressed by the uplift of the Uatumã River flood plain, portrayed by pseudo-stereoscopic image and 3-D perspective view.