Chapter 2: Satellite Image Analysis

2-1 Objectives

The objectives of the survey are to produce a digital mosaic image using JERS-1/SAR data which cover the central part of the Paraná basin, make a photogeologic interpretation of the image to delineate geological structure, and study the supra-regional geological structure using Landsat TM image which cover the entire Paraná basin.

2-2 Processing and Production of JERS-1/SAR Image

2-2-1 Outline of the Survey Area

Fig. II-2-2-1 shows the location of the survey area. The area is located in the center of the Paraná basin, ranging from 22° 00' to 30° 40' S latitude and from 57° 40' to 47° 45' W longitude, and has an area of about 500,000 km^2. This area traverses the Paraná basin in the ESE-WNW direction and is widely covered with flood basalts erupted from the Jurassic to the Cretaceous. Also, sedimentary rocks of the Paleozoic and granites (the basement) are distributed in the northeastern part of the area (See Fig. I-3-1-1).

The survey area is steep near the coastal mountains in the east and the undulating hilly country spreads from the central part to the western inland area. The area is a maximum of 1,000 meters above sea level. Trees grow thick from the coast to the inland area. There are not many trees and grassland plants grow abundantly in the inland hilly country where cattle is raised.

2-2-2 Satellite Data Used

Table II-2-2-1 lists the data used. In the present survey, 131 scenes of JERS-1/SAR data were used.

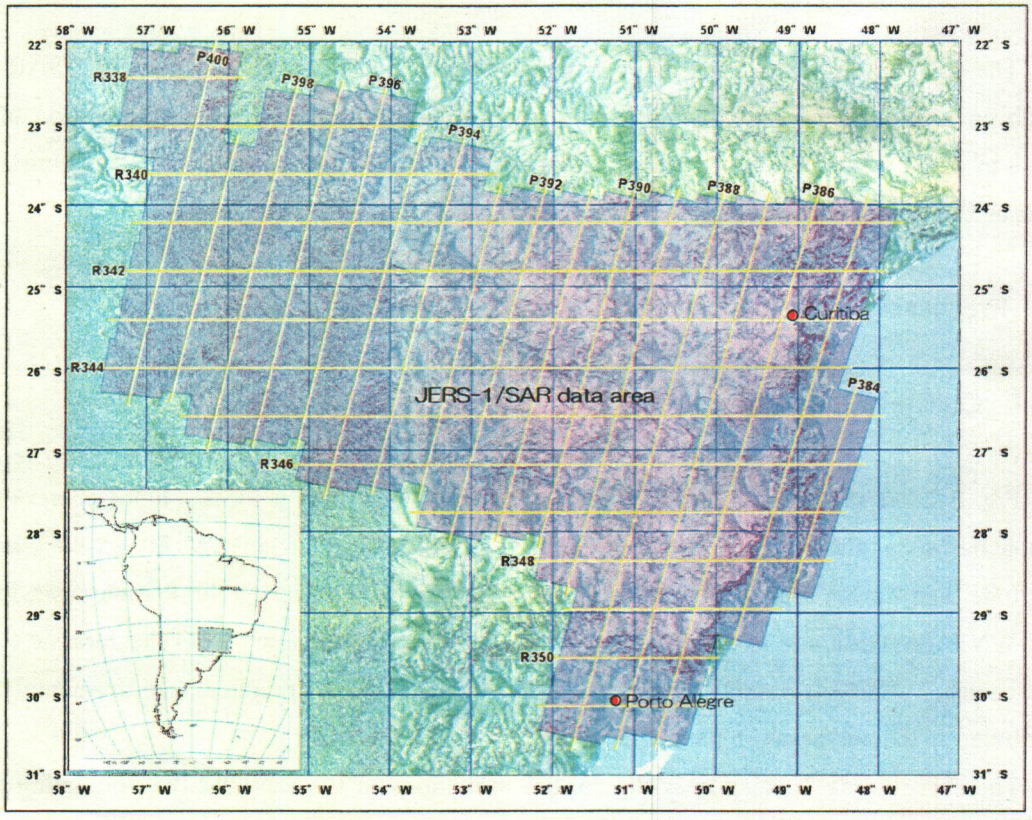

Fig.II-2-2-1 Location of JERS-1/SAR image analysis

Table II-2-2-1 List of JERS-1/SAR data

No.	Path	Row	Date	No.	Path	Row	Date	No.	Path	Row	Date
1	400	338	1993/6/21	51	393	342	1994/5/31	101	387	346	1994/8/21
2	400	339	1993/6/21	52	393	343	1994/5/31	102	387	347	1994/8/21
3	400	340	1993/6/20	53	393	344	1994/5/31	103	387	348	1994/8/21
4	400	341	1993/6/20	54	393	345	1994/5/31	104	387	349	1994/8/21
5	400	342	1993/6/20	55	393	346	1994/5/31	105	387	350	1994/8/21
6	400	343	1993/6/20	56	392	341	1993/9/8	106	387	351	1994/8/21
7	400	344	1993/6/20	57	392	342	1993/9/8	107	386	341	1996/6/10
8	399	338	1993/6/20	58	392	343	1993/9/8	108	386	342	1996/6/10
9	399	339	1993/6/20	59	392	344	1993/9/8	109	386	343	1996/6/10
10	399	340	1995/4/10	60	392	345	1993/9/8	110	386	344	1996/6/10
11	399	341	1995/4/10	61	392	346	1993/9/8	111	386	345	1996/6/10
12	399	342	1995/4/10	62	392	347	1993/9/8	112	386	346	1996/6/10
13	399	343	1995/4/10	63	391	341	1994/8/25	113	386	347	1996/6/10
14	399	344	1995/4/10	64	391	342	1994/8/25	114	386	348	1995/11/3
15	398	339	1993/10/28	65	391	343	1994/8/25	115	386	349	1995/11/3
16	398	340	1993/10/28	66	391	344	1994/8/25	116	386	350	1995/11/3
17	398	341	1993/10/28	67	391	345	1994/8/25	117	386	351	1995/11/3
18	398	342	1993/10/28	68	391	346	1994/8/25	118	385	341	1993/9/1
19	398	343	1993/10/28	69	391	347	1994/8/25	119	385	342	1993/9/1
20	398	344	1993/10/28	70	390	341	1993/9/6	120	385	343	1993/9/1
21	398	345	1993/10/28	71	390	342	1993/9/6	121	385	344	1993/9/1
22	397	339	1992/5/17	72	390	343	1993/9/6	122	385	345	1993/9/1
23	397	340	1992/5/17	73	390	344	1993/9/6	123	385	346	1993/9/1
24	397	341	1992/5/17	74	390	345	1993/9/6	124	385	347	1993/9/1
25	397	342	1992/5/17	75	390	346	1993/9/6	125	385	348	1993/9/1
26	397	343	1992/5/17	76	390	347	1993/9/6	126	385	349	1993/9/1
27	397	344	1992/5/17	77	389	341	1995/12/20	127	384	344	1994/5/22
28	397	345	1995/1/10	78	389	342	1995/12/20	128	384	345	1994/5/22
29	396	339	1995/4/7	79	389	343	1995/12/20	129	384	346	1994/5/22
30	396	340	1995/4/7	80	389	344	1995/12/20	130	384	347	1994/5/22
31	396	341	1995/4/7	81	389	345	1995/12/20	131	384	348	1995/2/10
32	396	342	1995/4/7	82	389	346	1995/12/20				
33	396	343	1995/4/7	83	389	347	1995/12/20				
34	396	344	1995/4/7	84	389	348	1995/2/15				
35	396	345	1995/4/7	85	388	341	1993/9/4				
36	395	340	1993/6/15	86	388	342	1993/9/4				
37	395	341	1993/6/15	87	388	343	1993/9/4				
38	395	342	1993/6/15	88	388	344	1993/9/4				
39	395	343	1993/6/15	89	388	345	1993/9/4				
40	395	344	1993/6/15	90	388	346	1993/9/4				
41	395	345	1993/6/15	91	388	347	1993/9/4				
42	395	346	1993/6/15	92	388	348	1993/9/4				
43	394	340	1993/6/14	93	388	349	1993/9/4				
44	394	341	1993/6/14	94	388	350	1993/9/4				
45	394	342	1993/6/14	95	388	351	1993/9/4				
46	394	343	1993/6/14	96	387	341	1994/8/21				
47	394	344	1993/6/14	97	387	342	1994/8/21				
48	394	345	1993/6/14	98	387	343	1994/8/21				
49	394	346	1993/6/14	99	387	344	1994/8/21				
50	393	341	1994/5/31	100	387	345	1994/8/21				

2-2-3 Processing and Production of Image

(1) Procedures for Processing and Producing Image

Geomatica Prime ver. 7.0 manufactured by PCI Inc. in Canada was used to perform various types of image processing. The procedures for processing and producing image are as shown in Fig. II-2-2-2.

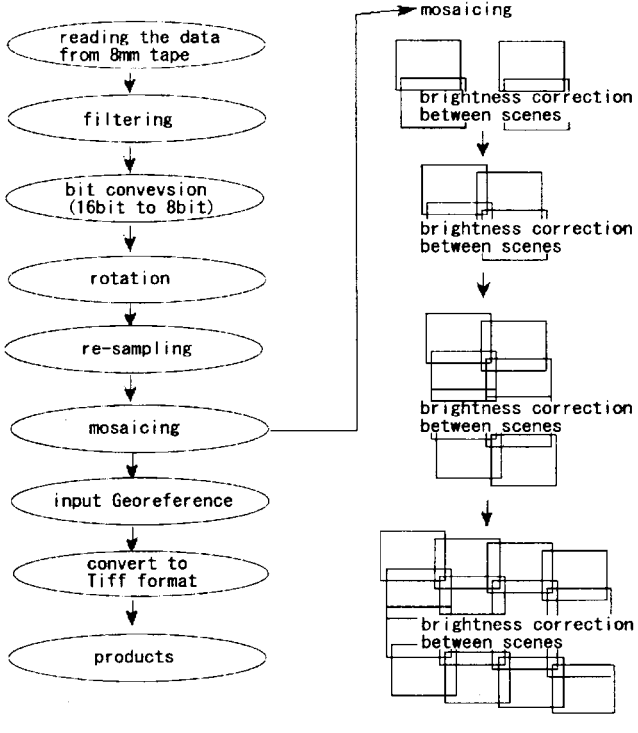

Fig.II-2-2-2 Flow chart of producing JERS-1/SAR mosaic image

(2) Image Processing Method

a) Filtering

A 3- by 3-pixel median filter was applied to the filtering. This application reduced black-and-white speckle noise.

b) Re-sampling

Raw data has an earth's surface resolution of 12.5 m per pixel. In order to enhance the processing speed, re-sampling was performed so that the image size could be 1/4. Consequently, the final image has an earth's surface resolution of 50 m per pixel.

c) Digital Mosaic Processing

In the digital mosaic processing, 20 to 200 GCPs were collected at each joint and the brightness among scenes was optimized to improve junction accuracy.

d) Inputting Georeference

A 1:500,000 scale TPC topographic map including the survey area was used to convert image data into georeference. About 100 GCPs were collected to enhance the georeference accuracy as much as possible.

e) Outputting Image

In the print-out, 1: 1,000,000 and 1: 500,000 scale images were output with titles, scales, and other information added. Mercator projection was adopted. Fig. II-2-2-3 shows the output example.

2-3 Interpretation and Analysis of the Image

2-3-1 JERS-1/SAR Image

A 1:500,000 printed-out mosaic image was used for interpretation and analysis. Lineaments and circular structures were extracted to interpret and analyze the geological structure. Lineaments that were confirmed as a fault on the existing geology and confirmed as a fault on the image are shown in the interpretation map (Fig. II-2-3-1). The extracted lineaments and circular structures were converted into ARC-VIEW-compatible digital data.

(1) Lineaments

In the Ponta Grossa Arch, the northeastern part of the survey area, some clear lineaments corresponding to faults on the existing geological map and many lineaments of the same system were extracted. In the Ponta Grossa Arch, sedimentary rocks of the Paleozoic and granitic basement rocks are distributed, and a great number of doleritic dikes considered to be feeders of flood basalts occur. The dikes have a strike extension of up to 80 km in the NW-SE direction. These dikes have been extracted as extremely clear lineaments on the image. This is attributable to the fact that a dike forms ridge-like continuous landform in sedimentary rocks which have little resistance to erosion. No dike that exists in granites of the basement has been extracted. This is due to the fact that a dike does not present a ridge-like landform because there is not much difference in resistivity to erosion between a dike and granites.

In the flood basalts area, a considerable amount of lineament groups in the NE-SW direction was extracted in the center of the survey area. These lineament groups, which have

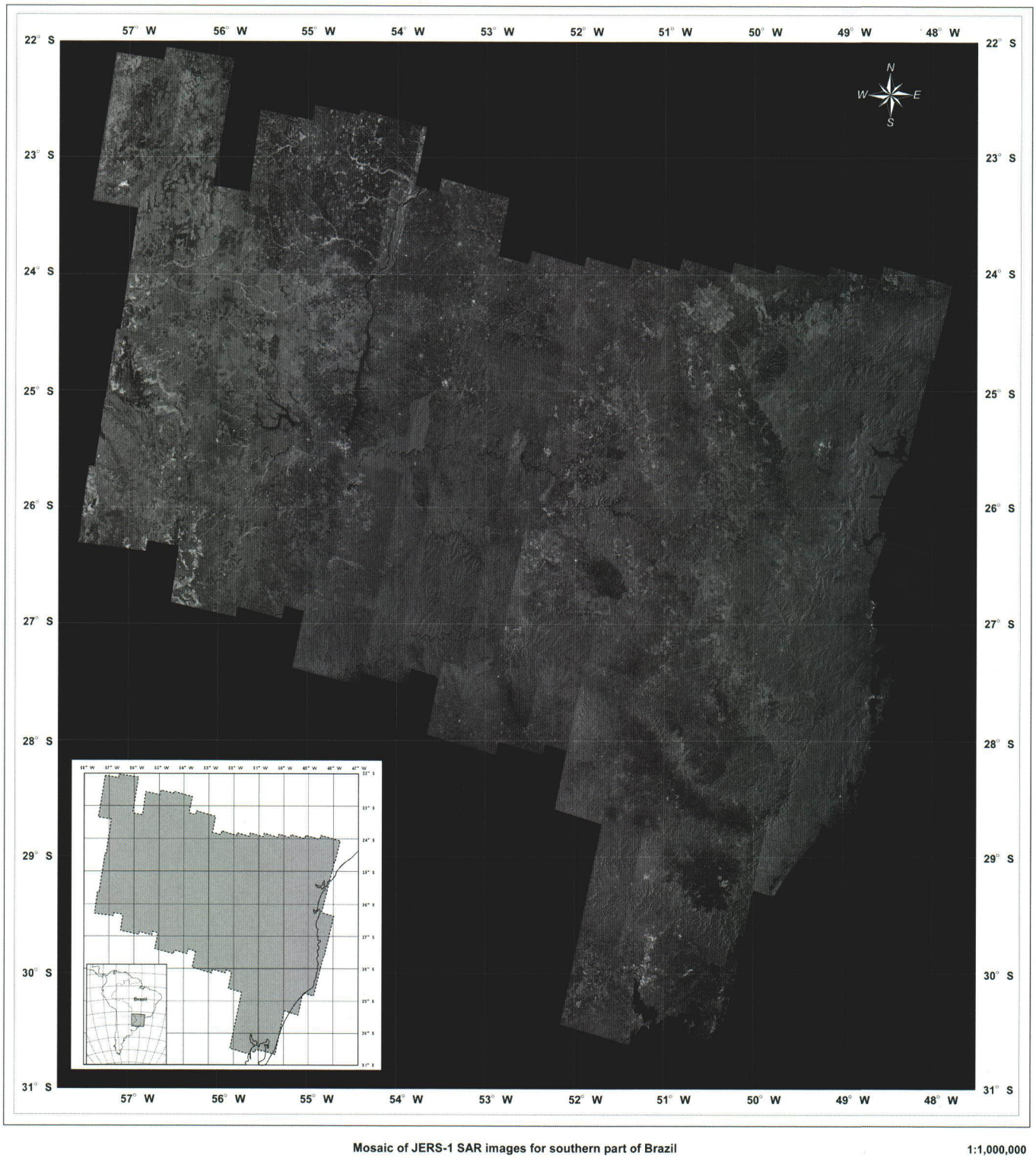

Fig.II-2-2-3 JERS-1/SAR mosaic image

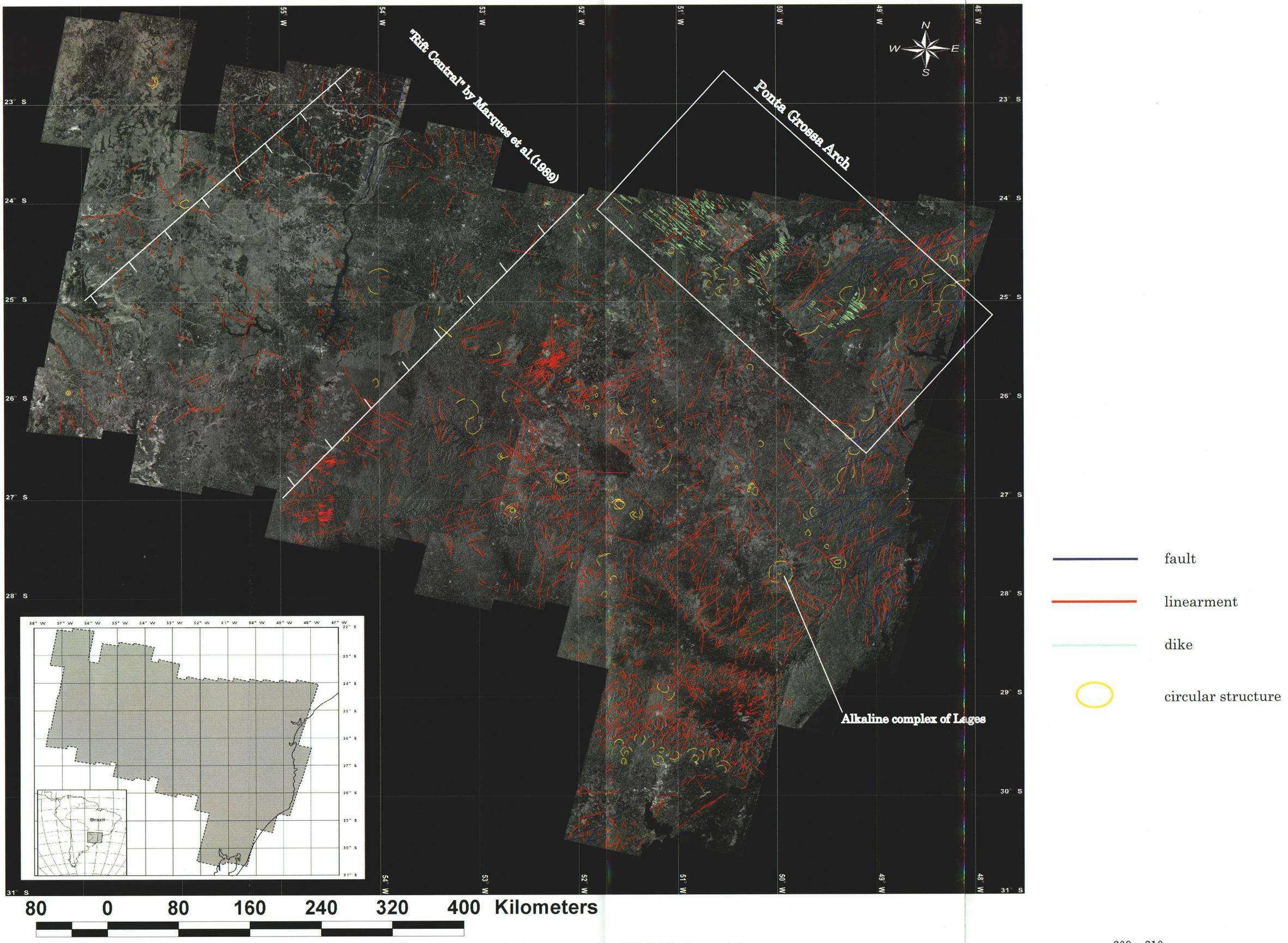

Fig.II-2-3-1 Interpretation map based on JERS-1/SAR mosaic image