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7.5 The 31 December 1992 seismic event on Novaya Zemlya

The small 31 December 1992 event (m_b 2.5) on Novaya Zemlya (Kværna and Ringdal, 1993) has attracted considerable attention in the nuclear monitoring research community. In particular, it has been used as an example to test the effectiveness of seismic identification tools.

Johnny Skorve of the Norwegian Institute of International Affairs is an expert in interpretation of satellite imagery and has previously conducted an investigation of the northern Novaya Zemlya test site (Skorve and Skogan, 1992). We have asked Johnny Skorve to study satellite imagery available from the general area to the NE of the test site where Carter et al. (1993) located the 31 December 1992 event. Even though both the location and nature of this event are very uncertain (a location at the test site cannot entirely be ruled out, and the event may well be a small earthquake), this study by Skorve serves to illustrate the potential and limitations of satellite imagery in a real monitoring situation. The text that follows is as provided by Skorve.

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A magnitude 2.5 event was detected on Novaya Zemlya on 31 December 1992. NORSAR located the event to about 30 km NNE of the northern test site. The Norwegian Institute of International Affairs (NUPI) is studying the Novaya Zemlya nuclear test site using Landsat and SPOT images.

Fortunately the satellite imagery made available for this study also includes the area where the 31 December 1992 event probably took place. However, this part of the imagery had not been processed when considerable attention was focused on the event. NUPI is cooperating closely with Tokai University Research and Information Center (TRIC) in Tokyo, Japan. During a working session at TRIC in November 1993, Johnny Skorve (NUPI) and Masahiro Etaya (TRIC) produced sets of high quality satellite images of the 31 December 1992 event area. Both SPOT panchromatic 10 m resolution and Landsat - TM (multispectral) 30 m resolution images were made. In addition, the SPOT and Landsat data were digitally merged to produce high resolution color images of the area. This type of image processing makes it possible to utilize the strong sides of each satellite, i.e., the high resolution of SPOT and the discriminating capacity of the multispectral Landsat.

The study area was defined by the information in the report by Carter et al. (1993), in which the event was relocated using two different master event methods. The two event locations using method 1 (Herring and Ryaboy travel time curves, respectively) and the three event locations using method 2 (JB, IASPEI 91 and Ryaboy travel time curves, respectively) have all been located on the satellite images.

During the NUPI study of the Novaya Zemlya nuclear test sites, it has been possible to observe and map the infrastructure connected with these locations. The question was therefore raised: is it possible to see any infrastructure or activity that can be related to the 31 December 1992 event?

To facilitate such a search, during the working session in Tokyo in November 1993, subscenes both in black/white and color were produced that were centered around the calculated coordinates of the five locations mentioned above. The DMA digital terrain data of that area was also used. The available maps of Novaya Zemlya are all small-scaled, 1:1 mill. ONC and 1:500 000 TPC maps, and this is far from adequate for use in the study of this rather small area. The description of the area is to a large degree based on interpretation and analysis of satellite images.

The northern nuclear underground test site is situated in the southwestern part of the Matochkin Shar in the Shumilikha valley area. The 31 December 1992 event is, however, assumed to be located on the northern side of the Shar, on the eastern part of Novaya Zemlya (Fig. 7.5.1).

The 31 December event coincides with the central part of a valley running diagonally across the southernmost part of the Severny, the northern island (Fig. 7.5.1). The Matochkin Shar is wider in its eastern part and here the 12 km long Belushii bay branches off the Shar in a northerly direction. At its end a delta with shallow frontal water has been formed by fluvial sediment off-loading from the river's suspended material. The southeastern shore of the Belushii bay is situated at the foot of the Bremerhafen Mountain, and to the north of it is a low and flat area with some small lakes.

On the western side of the bay entrance, the Severnaya mountains rise directly from the sea to a height of more than 800 m above sea level. To the northeast of the Belushii valley is a glacier-covered mountain reaching 1140 m above sea level. In the northern part of the area, to the west of the valley, is another mountain. Its summit reaches 1175 m above sea level, and here glaciers are moving radially down. The largest of these goes all the way down to the valley floor where it has left a large semicircular terminal moraine 4 km in diameter. The glacier front had by the time image acquisition began receded approximately 4 1/2 km. The melt water from this large glacier drains northward to the Mityushikha fjord on the west coast of Novaya Zemlya. The poorly defined watershed is situated just east of the glacier. The color, multispectral Landsat-TM image enhances the low topography by the delineation of the vegetation cover. Satellite imaging during late August is most favorable in differentiating vegetational vigor. SPOT imagery for 1989 showed that all snow had melted except for the mountain summit areas and the upper parts of the glaciers.

The satellite images show that the summer of 1989 was considerably more favorable in the Matochkin Shar area compared with that of 1992. Generally, Novaya Zemlya is characterized by a severe climate with a cold, long winter. Meteorological data for the Malyye Karmakuly station on the west coast, south of the northern nuclear test site, show that the mean air temperature here rises above freezing in early June until the end of September. During very favorable weather conditions, the temperature can rarely, and for short periods, exceed 20°C, but the mean air summer temperature is between 4 and 5°C. The 31 December 1992 event area is located about 160 km north of the Malyye Karmakuly station, and the climate here is considerably more severe than on the southwest coast of Novaya Zemlya. Even the floor of the Belushii valley is probably completely snow-covered until late May/early June.

The color satellite image shows that the vegetation is present along the whole length of the valley, from Belushii bay to the inner part of the Mityushikha fjord. Due to the severity of the climate, the vegetation is only found in the coastal belt along the Matochkin Shar and in the low valleys. The vegetation is absent in areas above 150-200 m above sea level. Judging from the distribution of the vegetation alone, one may conclude that the Belushii valley is, as mentioned above, low levelled and flat at its base, and this is verified by the digital terrain data.

On the digitally merged SPOT and Landsat-TM images of the Belushii valley area, TRIC superimposed a geographical grid. By using this, the five seismically determined locations of the 31 December 1992 event were plotted on to the satellite images. The areas centered around these were photo-interpreted in an effort to trace and detect any human activities. The study area is shown in Fig. 7.5.2, with the five event locations from Carter et al. (1993) superimposed.

The event locations

A survey was made of the five locations. With respect to the accessibility, the locations denoted IASPEI 91 and Herrin have the best positions close to the innermost part of the Belushii bay and thus easy to reach by ship during the summer season. Ryaboy1 is further north, 2/3 of the way upstream between the bay and the watershed. The JB location is the most distant of the five. It is on the northern side of the valley that is draining towards the Mityushikha fjord. Ryaboy 2 is located on a mountain ridge about 7 km west of the IASPEI 91 site.

IASPEI 91

The coordinates of IASPEI 91 coincide with the southern rim of the large alluvial fan that is blocking most of the valley floor immediately north of the river-delta at the end of the Belushii bay. The alluvial fan measures 1.5 x 2.2 km. The material that accumulated on the western slope to form this impressive alluvial fan was transported by water through the canyon running in an ENE direction. The material is distributed in a fan shape way from the fan head at the lower end of the canyon. The scarp or the boundary between the distal side of the fan and the hard rock of the valley side is very distinct, as seen on the color satellite images. That is because the bedrock is apparently covered by quite dense vegetation while the surface of the fan is nearly devoid of vegetation except for some scattered patches on its lowest part.

On the rocky slope about 250 m west of the scarp and about 650 m south of the canyon, there is an area about 50-60 m in diameter that appears to be completely depleted of vegetation in strong contrast to the surroundings. This spot has a brown-grayish color similar to the barren topsoil on the surface of the alluvial fan below. There also seems to be a path from it and down to the scarp where a small alluvial fan meets the large one. The site is only some hundred meters southwest of the coordinates for IASPEI 91, but the resolution

of the satellite images is too poor to establish if this small feature is related to any human activity. It is more probable that the suspected track is a natural landscape feature like a creek or a scar caused by a small rockfall, landslide or avalanche. Fig. 7.5.3 shows a scene from the area around the IASPEI 91 location, with the large alluvial fan near the middle of the picture. The small feature discussed in the text above is marked by an arrow.

Herrin

Herrin is located 3 km north of IASPEI 91, northeast of the large alluvial fan and east of the Belushii braided river. The exact coordinates coincide with the somewhat elevated rocky shoulder about 200 m from the scarp down towards the riverside. The lowest part has rather dense vegetation, while the other half of the landscape seems to have more scattered vegetation. In some of the more shadowed locations, small snow patches can be seen. However, there are no signs of human activity in this area.

Ryaboy 1

Ryaboy 1 is found 8.8 km due north of IASPEI 91 and on the northern side of a large canyon. Its river deposits have formed an alluvial fan. The river constitutes the main discharge of water into the valley where the outer part of this alluvial fan transforms into the braided river system. The coordinates of Ryaboy 1 are just above the vegetation limit in an area where very reflective rocks are exposed. There is no indication of any human activity here.

JB

JB is located 23.5 km northwest of IASPEI 91 and about 5 km north of the largest glacier in the area, described earlier in the text. JB is situated above the vegetation limit and in a rather rough terrain on the western side of the valley leading to the Mityushikha fjord. It is not probable that any human activity is present on this valley slope covered by banks of snow.

Ryaboy 2

Ryaboy 2 is located 6 1/2 km due west of IASPEI 91. This is on a plateau stretching from the southern part of the Belushii valley to the Syedlho mountain near the Matoshkin Shar. Ryaboy 2 has the highest elevation of all five sites. The Ryaboy 2 coordinates coincide with an area about 800 m above sea level. The landscape is quite rugged and hostile. In the surroundings there are several small glaciers and many permanent snowfields. It is very unlikely that human activities should take place in such a desolate area.

Conclusions

The high quality of the satellite images produced for this study fail to show any certain signs of human activity that can be related to the 31 December 1992 event. This conclusion is based on experience gained during the satellite study of the Novaya Zemlya nuclear underground test site in the nearby Shumilikha valley on the southwestern side of the Matochkin Shar. The infrastructure and main feature related to the testing activities here are visible and have been mapped using satellite images. SPOT's 10 m resolution is, however, not fully satisfactory since a lot of the medium and almost all the fine details are lost. This has to be taken into consideration when the results of the 31 December 1992 event are evaluated.

However, if facilities and infrastructure such as those found in a number of places within the northern test site also had been present even to a limited extent in the 31 December 1992 event area, it would have been discovered during the photo-interpretation. It should also be noted that the presence of vegetation always facilitates the discovery of infrastructures and man-made features. In contrast, barren landscapes, of the type that dominate Novaya Zemlya, have generally the property of concealing such features.

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References

Carter, J., H. Israelsson and V. Ryaboy (1993): Location of the December 31, 1992, Novaya Zemlyan Event, Center for Seismic Studies, 12 April 1993.

Kværna, T. and F. Ringdal (1993): Monitoring a moratorium: An experiment in continuous seismic threshold monitoring of the northern Novaya Zemlya test site, in *Semi-annual Tech. Summ., 1 October 1992 - 31 March 1993*, NORSAR Sci. Rep. No. 2-92/93, Kjeller, Norway.

Skorve, J. and S.K. Skogan (1992): The NUPI Satellite Study of the Northern Underground Nuclear Test Area on Novaya Zemlya. NUPI Research Rep. No. 164, Oslo, Norway.

Fig. 7.5.1. The Matochkin Shar area of Novaya Zemlya with nuclear test site (circled) and the satellite imagery study area (shown enlarged in Fig. 7.5.2) to the east of the test site. (DMA DIGITAL TERRAIN DATA)

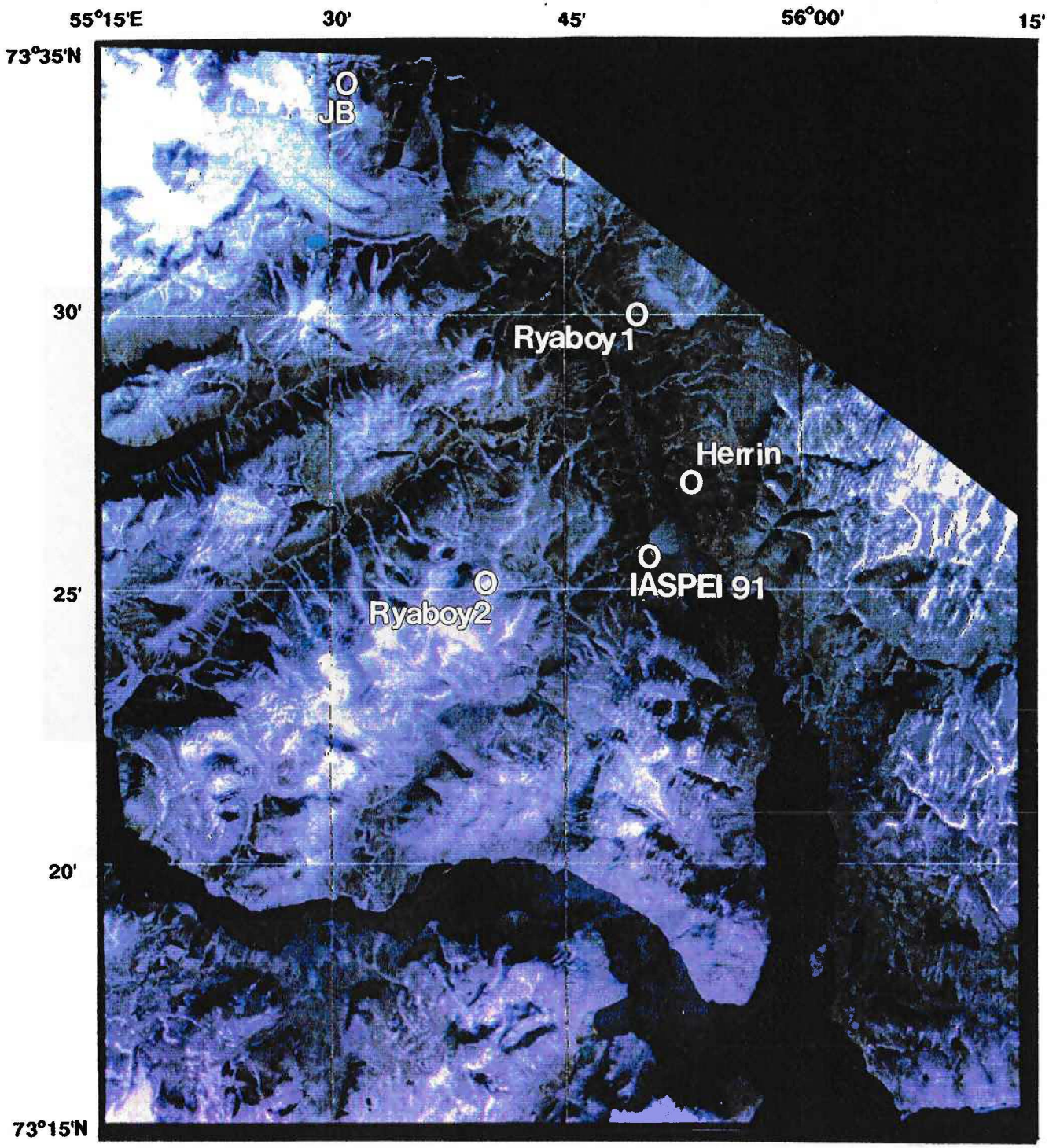

Fig. 7.5.2. Satellite imagery of the study area to the east of the northern Novaya Zemlya test site. The five different event locations for the 31 December 1992 event are from Carter et al (1993). Locations denoted "Herrin" and "Ryaboy1" refer to method 1 in Carter et al (1993), whereas locations denoted "JB", "IASPEI 91" and "Ryaboy2" refer to method 2. (PHOTO: SPOT IMAGE; IMAGE PRODUCTION: TRIC, TOKYO. DIGITALLY MERGED SPOT-P AND LANDSAT-TM IMAGES)

Fig. 7.5.3. Satellite imagery for an area around the IASPEI 91 event location. The small feature marked by an arrow is discussed in the text. (PHOTO: SPOT IMAGE; IMAGE PRODUCTION: TRIC, TOKYO. DIGITALLY MERGED SPOT-P AND LANDSAT-TM IMAGES)