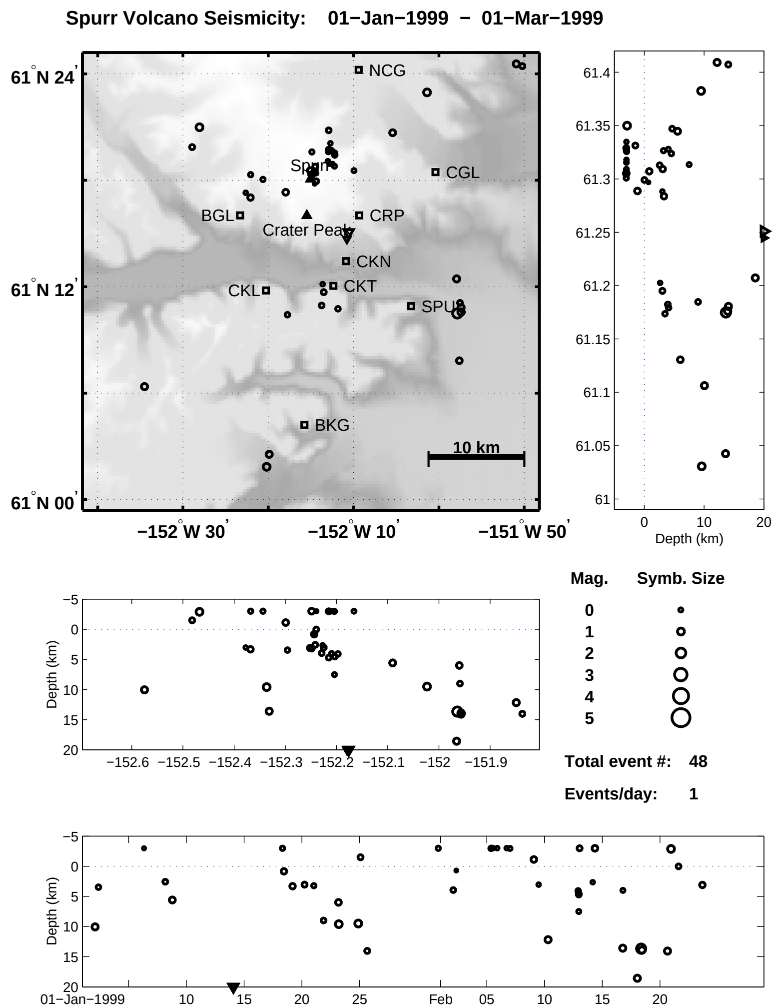

Figure 8a: Locatable Spurr seismic events in space and time for Janurary through February.

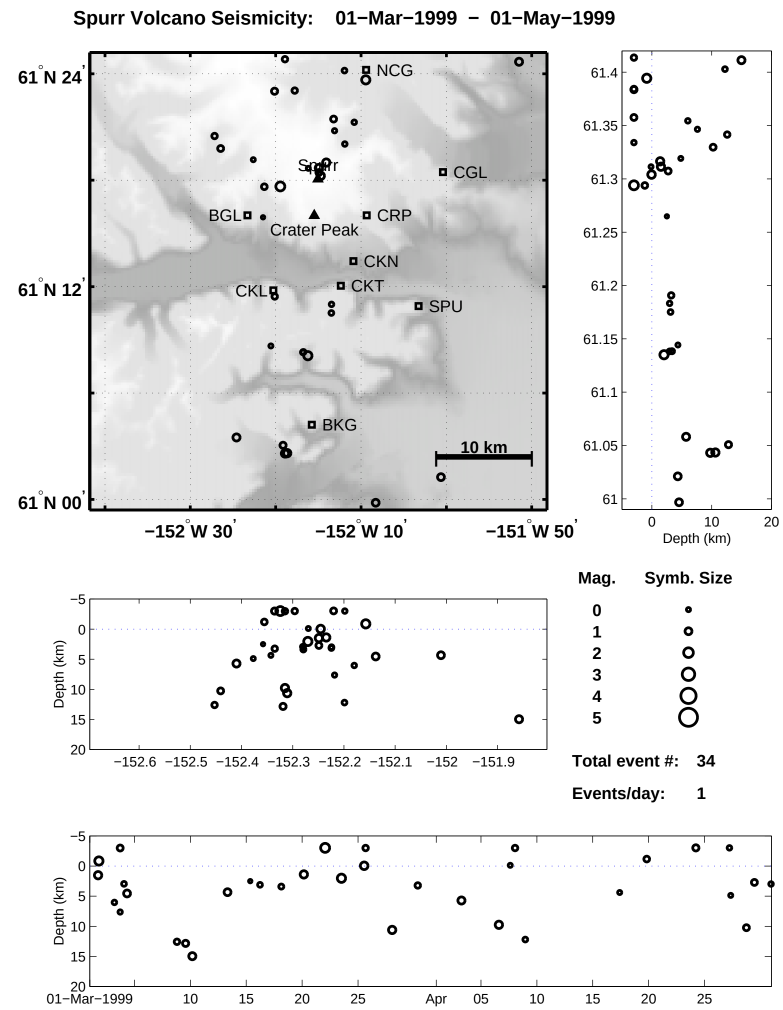

Figure 8b: Locatable Spurr seismic events in space and time for March through April.

Seismicity

This is once again a double issue of the Bi-monthly Report. As has been the case in the past the seismicity plots and corresponding discussion were divided into two time periods consisting of two-months each (i.e. January-February 1999 and March-April 1999).

Spurr/Strandline Lake Region: January-February 1999:

A total of 48 earthquakes were located in the Spurr region during January-February 1999 (figs. 8a, 26a and 27b). The largest of these events had a magnitude of M_L=1.5 was located about 5 km east-southeast of Crater Peak (~7 km southeast of Spurr), and had a hypocentral depth of about 24 km. Immediately following this event was a second deep earthquake having nearly the same hypocentral location. In addition to these two events, there were another 27 earthquakes located within 10 km of the summit of Spurr. Most of these events were located in two roughly north-south trending clusters of activity, each about 4 km in length. One cluster was in the summit area while the second cluster was further (~3 km) northeast of the summit. The summit cluster was comprised of eight earthquakes and extended from about 0.5 km east-southeast to about 3 km north of the summit. The second cluster consisted of 12 events and extended from about 3 km east-northeast to about 6 km north-northeast of the summit. Although the majority of these 12 events have shallow hypocentral depths four had depths of ~4-8 km. Of the remaining seven “proximal” events four were located about 5-7 km west to west-southwest of the summit. Another proximal event was located about 3 km west-southwest of the summit. One more of these events was located about 10 km east-northeast of the summit

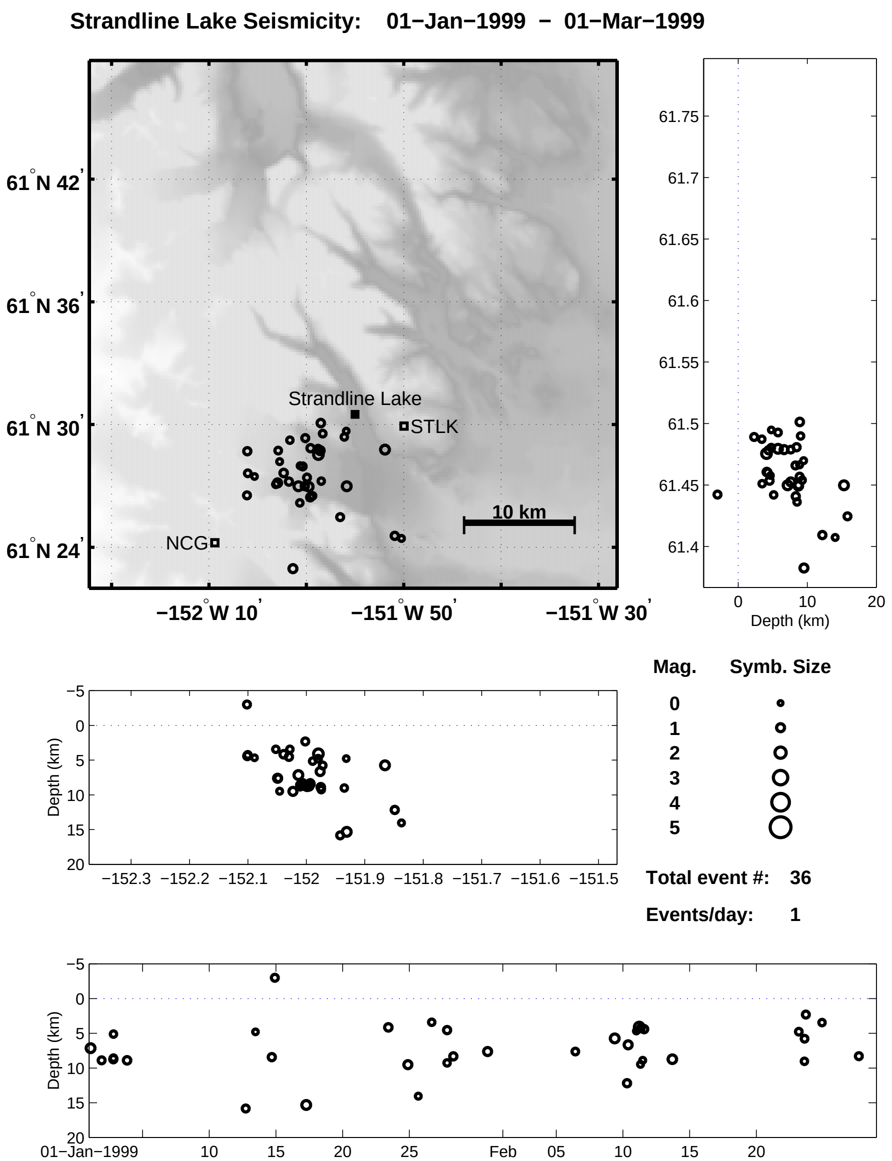

Figure 9a: Locatable Strandline Lake seismic events in space and time for January through February.

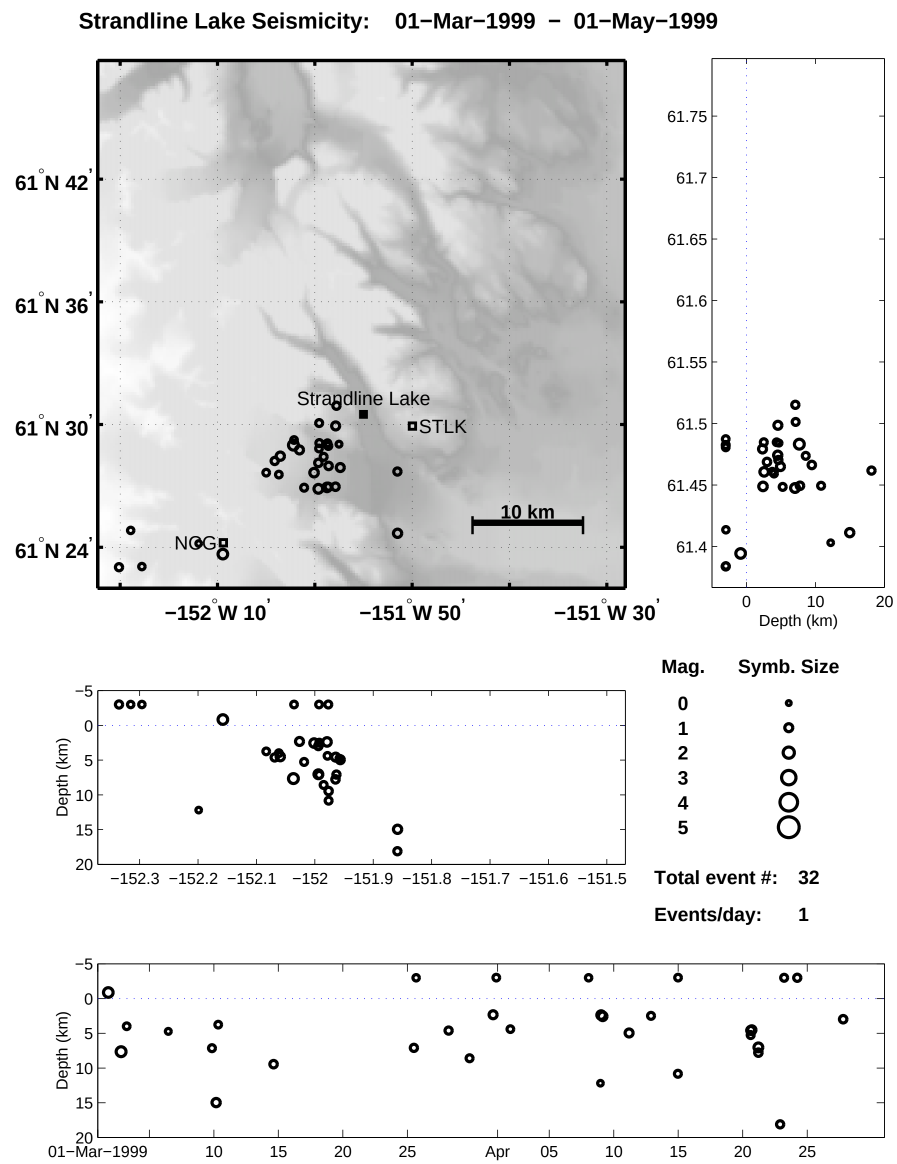

Figure 9b: Locatable Strandline Lake seismic events in space and time for March through April.

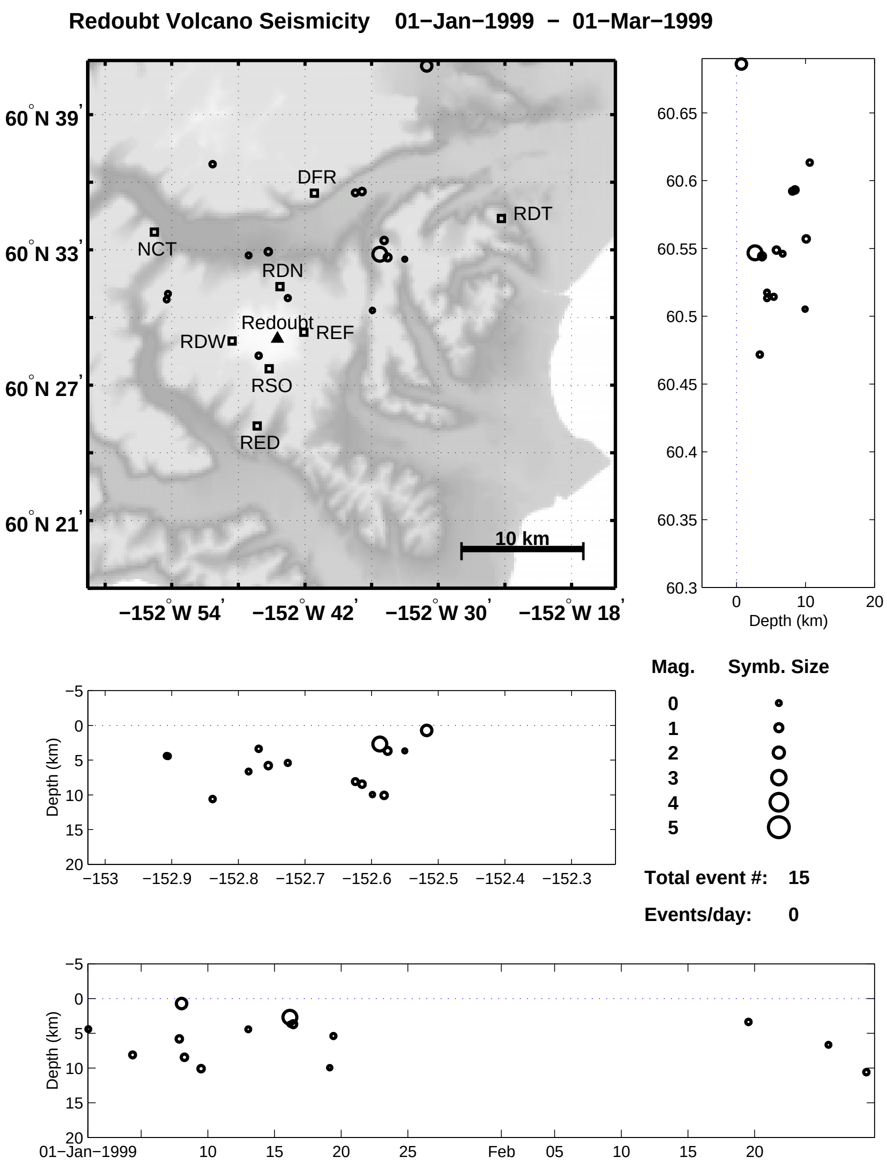

Figure 10a: Locatable Redoubt seismic events in space and time for January through February.

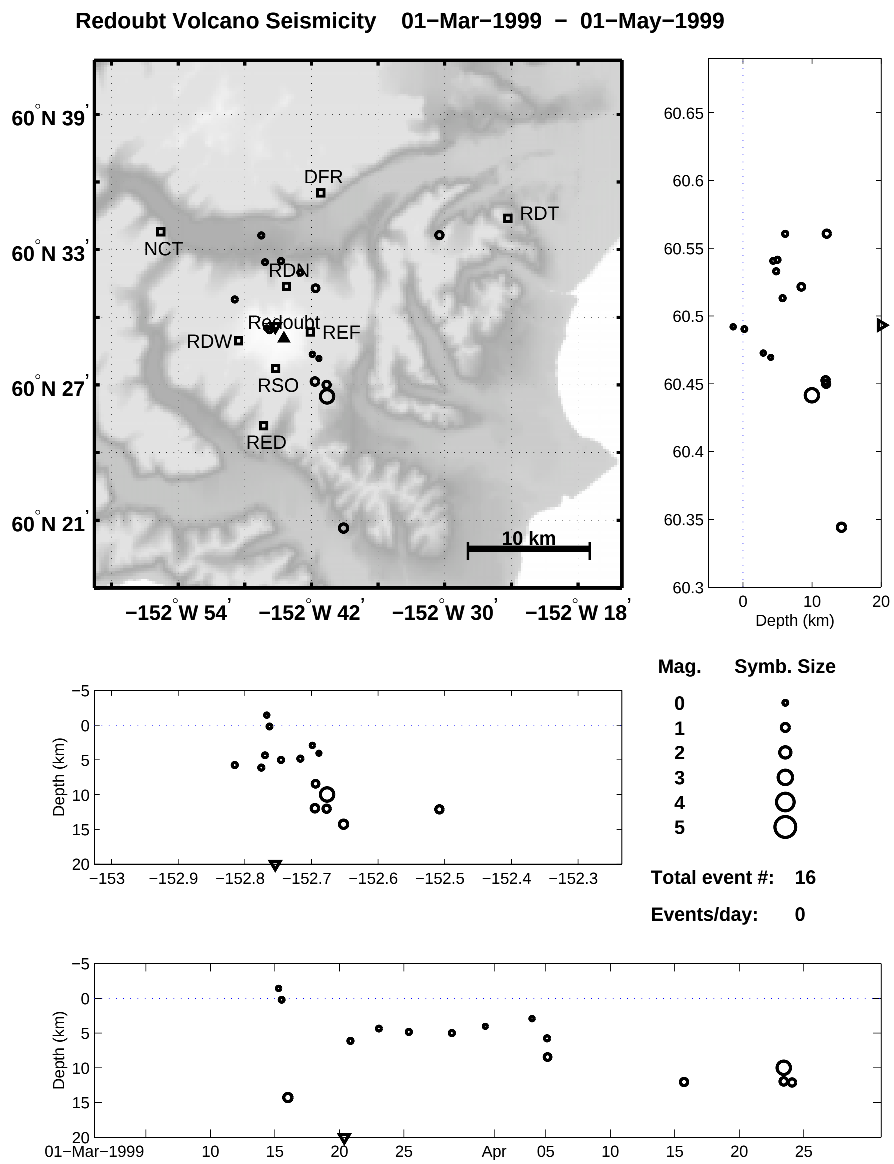

Figure 10b: Locatable Redoubt seismic events in space and time for March through April.

and had a hypocentral depth of about 6 km. The final proximal event was located about 5 km east-northeast of Spurr. Most of the proximal events (i.e. 22 events) had hypocentral depths of less than 4 km, of which 16 were located above sea-level. The number of proximal events located during January-February 1999 was nearly twice that of the previous two-month period (i.e. 29 vs. 16 events). This value was also twice the number of proximal events predicted from the Spurr five-year mean seismicity rate. The remaining 19 more distal events were located quite some distance from both Spurr and Crater Peak and were probably regional tectonic events unrelated to volcanic activity in this region. The three northernmost of these events were also plotted on the Strandline Lake seismicity map (fig. 9a) and thus should be considered part of the ongoing Strandline Lake activity.

During January-February 1999 there were a total of 36 earthquakes located in the general Strandline Lake region (fig. 9a). The largest of these events had a magnitude of M_L=1.3. The number Strandline Lake events located during this two-month period was much greater than the 21 such events located during the November-December 1998 period.

March-April 1999:

Thirty-four earthquakes were located in the Spurr region during March-April 1999 (figs. 8b, 26b and 27b). Of these 34 events a total of 14 were located within 10 km of the summit of Spurr. Five of these proximal events were clustered about 1-2 km north of the summit. The remaining nine proximal events were scattered throughout the region northeast to southwest of the summit. One of these events was located about 4 km west of the summit. This event had a magnitude of M_L=1.8 and was the largest event located in the Spurr region during this two-month period. Another event was located about 2 km west of the M_L=1.8 earthquake. One earthquake was located nearly 10 km north-northwest of the summit of Spurr. Four other events were located about 5-7 km north-northeast of the summit. One other event was located about 7 km southwest of the summit while the final proximal event was located the same distance west-northwest of Spurr. Eleven of the proximal events had hypocentral depths of less than 3 km of which seven were located above or close to sea-level. The remaining 20 more distal earthquakes were located relatively far away from Spurr and Crater Peak and were probably regional tectonic earthquakes not related to volcanic activity in the Spurr/Crater Peak region. The number of proximal events located during this two-month period was considerably lower than the 29 such events located during January-February 1999. This value was, however, only slightly lower than the 15-16 proximal events predicted from the mean seismicity rate of Spurr.

Thirty-two earthquakes were located in the Strandline Lake region during March-April 1999 (fig. 9b). The largest Strandline Lake event had a magnitude of M_L=1.6. The southernmost six of these events were also plotted on the Spurr seismicity map (fig. 8b). The southernmost event was located within 10 km of the summit of Spurr. This proximal event should not be included in the Strandline Lake event tally. The number of Strandline Lake events for this two-month period is thus 31 located earthquakes. This value is lower than the 36 Strandline Lake events located during January-February 1999.

Redoubt:

January-February 1999:

During January-February 1999 a total of 15 earthquakes were located in the Redoubt area (figs. 10a, 26a and 27a). The largest of these earthquakes had a magnitude of M_L=2.9 and was located about 11 km northeast of the summit. A total of seven earthquakes were located within 10 km of the summit. The largest proximal event had a magnitude of M_L=0.5 and was located about 7 km north of the summit. Slightly west of this earthquake was another event located about 7 km north-north-west of the summit. Two other proximal events were located nearly 10 km west-northwest of the summit of Redoubt. A proximal earthquake was located about 2 km southwest of the summit and the final such event was located about 8 km east-northeast of the summit. Of these proximal events the latter one had the largest hypocentral depth which was nearly 10 km. The other six proximal events had hypocentral depths of ~3-7 km. The eight nonproximal events were located relatively far away from Redoubt and, therefore, are probably regional tectonic events rather than being related to volcanic activity within the area. The number of proximal Redoubt earthquakes located during this two-month period was half that for November-December 1998. This value was also half that predicted by the 56-month Redoubt mean seismicity rate.

March-April 1999:

Sixteen earthquakes, the largest of which had a magnitude of M_L=2.7, were located in the Redoubt region during March-April 1999 (figs. 10b, 26b and 27b). There were 14 earthquakes which were located within 10 km of the summit of Redoubt. The magnitude M_L=2.7 earthquake was one of these proximal events and was located about 6 km southeast of the summit and a hypocentral depth of about 10 km. Two other events were located in the same area about 5 km from the summit. Another proximal event was located about 5 km northwest of the summit and had depth of 12 km. Five other earthquakes were located in a zone extending from about 5 km north-northeast to about 9 km north-northwest of the summit of Redoubt and had hypocentral depths of ~4-8 km. Two more events were located about 3 km south-south-east of the summit with depths of 3 and 4 km. The remaining three proximal events were located about 1 km northwest of the summit. Although these latter three events showed a tight clustering with respect to epicentral location, this was only partially the case with respect to their depths. Two of the events had very shallow hypocentral depths while the third one, indicated by the inverted triangle in figure 3B, had a hypocentral depth in excess of 34 km. The other 11 proximal earthquakes had hypocentral depths of ~3-12 km.

Iliamna:

January-February 1999:

During January-February 1999 a total of 14 earthquakes, the largest of which had a magnitude of M_L=1.4, were located in the Iliamna region (figs. 11a, 26a and 27a). One of these events was located nearly 29 km northeast of Iliamna. Because of its great distance from Iliamna this earthquake is clearly a regional event and is in no way associated with volcanic activity at Iliamna. The 13 earthquakes actually associated with Iliamna formed two tight clusters of activity. One cluster of seismicity was located about 1-2 km northeast of the summit and included seven earthquakes. These events all had hypocentral depths that were above or near sea-level. The second cluster of activity was located ~6-7 km south-southeast of the summit of Iliamna and was comprised of six earthquakes. The M_L=1.4 event was part of this more southern cluster of seismicity. The earthquakes of the second cluster of activity had hypocenters in the ~2-4 km range. Both clusters of seismicity occurred in areas that have been active quite often in the past. The number of events located in the Iliamna region during January-February 1999 was slightly greater than the 11 such events located during November-December 1998 but is in agreement with the number of events predicted from the Iliamna 1-year mean seismicity rate.

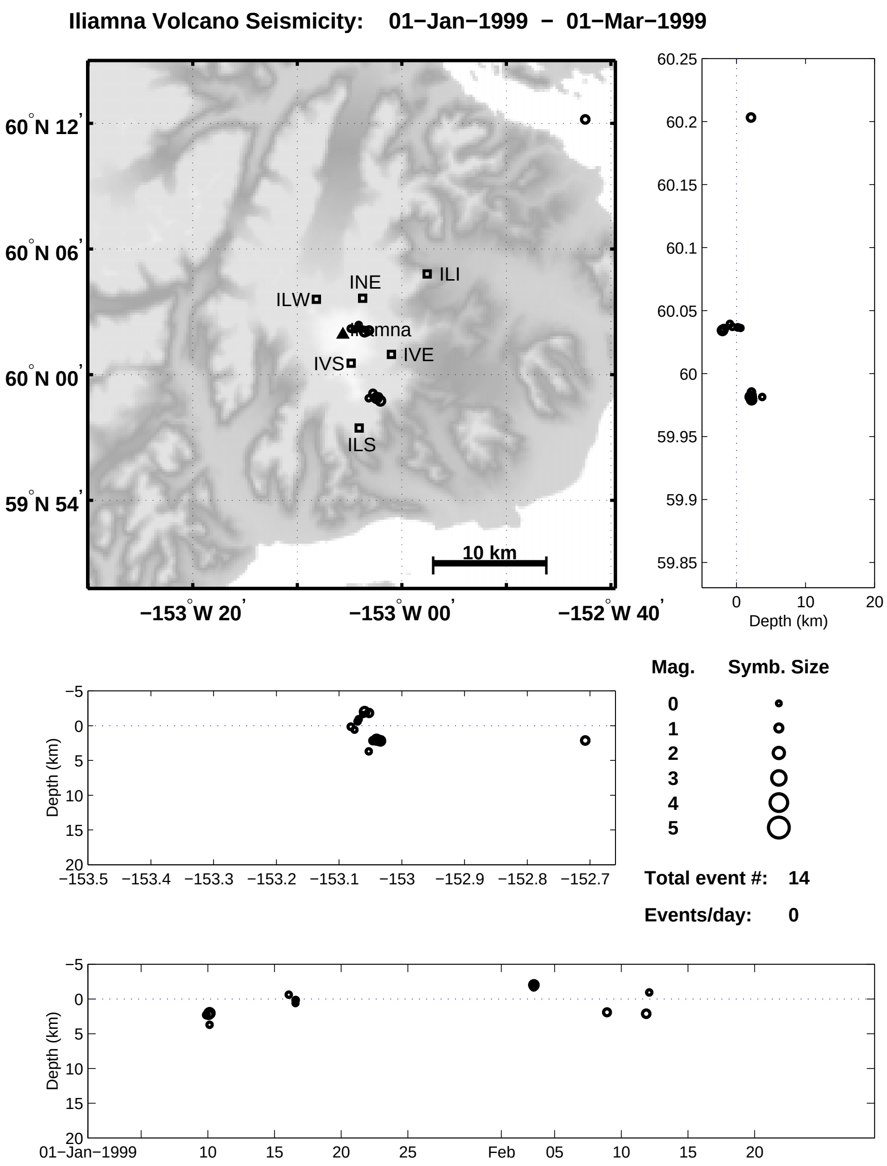

Figure 11a: Locatable Iliamna seismic events in space and time for January through February.

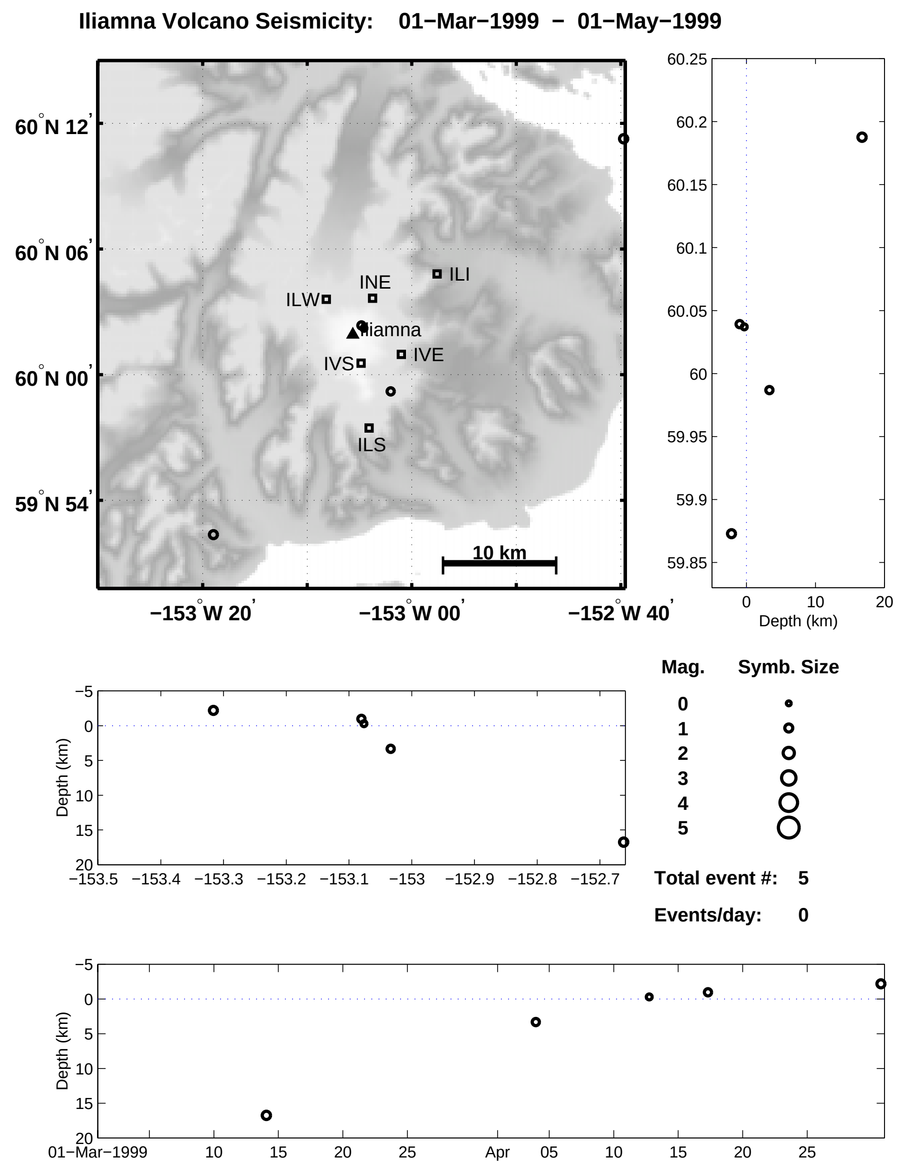

Figure 11b: Locatable Iliamna seismic events in space and time for March through April.

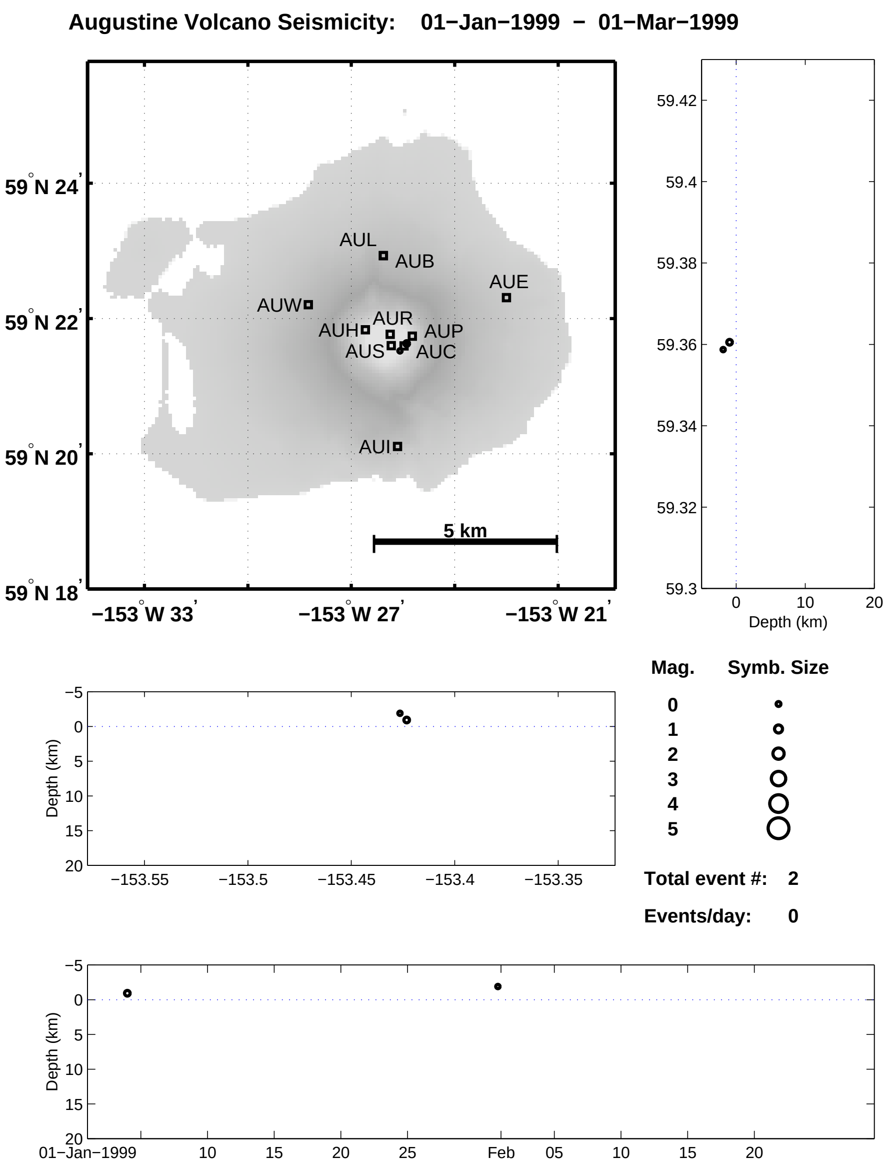

Figure 12a: Locatable Augustine seismic events in space and time for January through February.

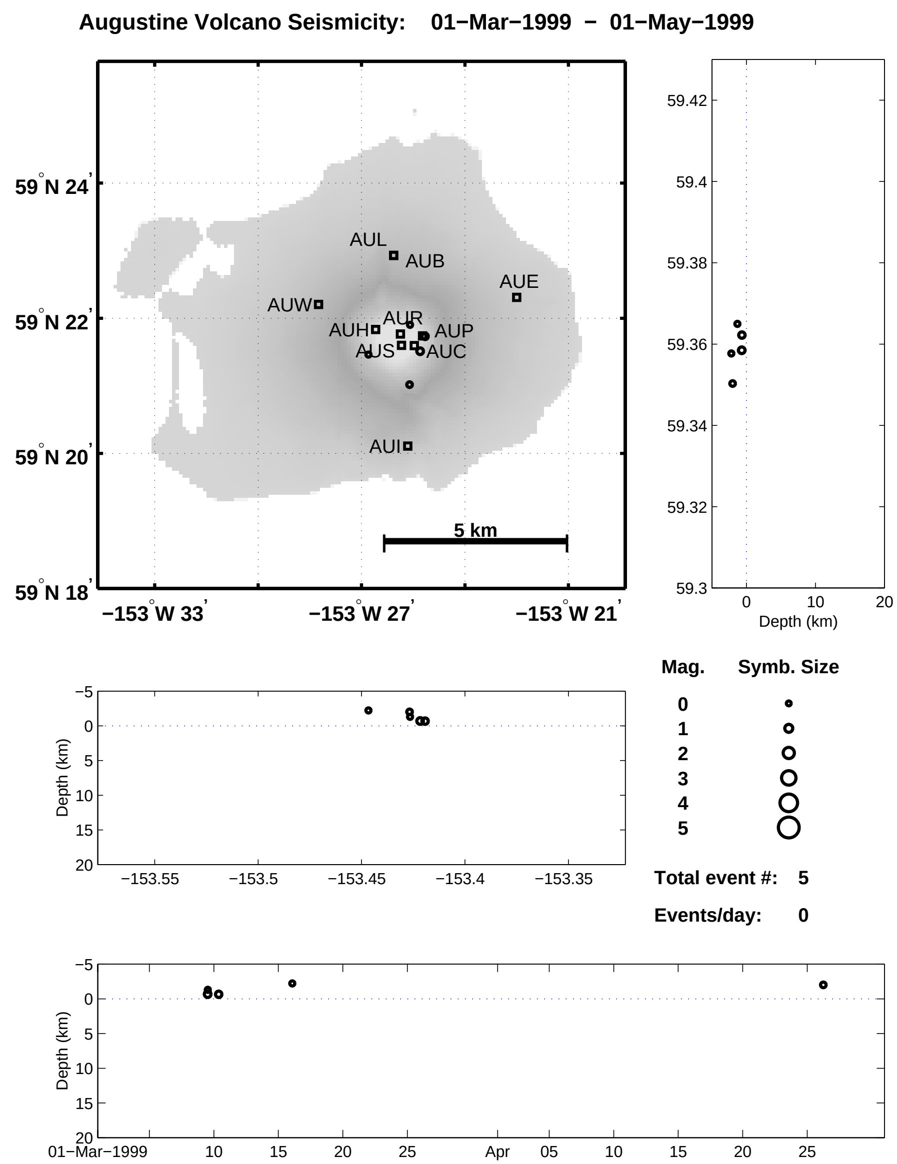

Figure 12b: Locatable Augustine seismic events in space and time for March through April.

March-April 1999:

Only five earthquakes were located in the Iliamna region during March-April 1999 (fig. 11b, 26b and 27b). The largest of these events had a magnitude of M_L=1.1 and was located nearly 30 km northeast of Iliamna. Due to its great distance from Iliamna this event is probably a regional tectonic earthquake and, thus not related to volcanic activity at Iliamna. The same thing can also be said of another event that was located about 22 km southwest of Iliamna. Two of the three events actually associated with the volcano were located about 1 km northeast of the summit and had shallow hypocentral depths (i.e. Z < 0.0 km). The third earthquake was located about 6 km south-southeast of Iliamna and had a hypocentral depth of about 3 km. The number of events located in the Iliamna area during this two-month period was considerably lower than that of January-February 1999 as well as the number of such events predicted from the mean seismicity rate. This lull in activity does, however, appear to have been genuine. Five of the six seismic stations (seven of eight components) of the Iliamna network were operating and being received throughout March and April, which was also the case during the previous two-month period.

Augustine:

January-February 1999:

Two events, the largest of which had a magnitude of M_L=0.3, were located in the Augustine region during January-February 1999 (figs. 12a, 26a and 27a). Both events were located in the summit area and had shallow hypocentral depths. The number of Augustine events located during January-February 1999 was much lower than the 19 such events located during November-December 1998. This value was also considerably lower than the 75 Augustine events predicted from the 10-month mean seismicity rate.

March-April 1999:

There were five Augustine events during March-April 1999 (figs. 12b, 26b and 27b). The largest events had a magnitude of M_L=0.6 and was located about 1 km southeast of the summit of Augustine. All but one of these events were located within 1 km of the summit. The remaining event was located about 2 km south-southeast of the summit. The number of earthquakes located in the Augustine area during this two-month period was greater than that of the previous period but was still much lower than the number of events predicted from the 10-month mean seismicity rate.

The extremely low number of events located at Augustine during January-February and March-April 1999 was most likely the result of station outages, particularly in the summit region. Since most of the seismicity at Augustine occurs in the summit area, the five summit stations (AUC, AUH, AUP, AUR, and AUS) are particularly important with respect to the monitoring of Augustine activity. Only the larger events tend to have discernible arrivals at the remaining four stations. As noted in the previous Bimonthly Report, one of the summit stations, AUC, was “out” and this continued to be the case during the four-month period discussed here. In addition to this station, AUS was out much of the time. AUP was also frequently out. Fortunately, both AUS and AUP were usually not out at the same time. Although station AUR was generally operating during this four-month period it was quite often very noisy. As a result, there were usually only three of the five summit stations operating with one of the remaining summit stations very noisy. Of the four non-summit stations, AUE was also frequently out. Generally, one can confirm that an apparent decrease in the level of seismicity is not the result of station outages by looking for similar changes in the relative level of activity in the Helicorder event counts. Coincident decreases in the seismicity would imply an actual decrease in the seismicity level rather than simply being the result of an increase in the detection threshold associated with station outages. A caveat of this is, of course, that the station employed for the event counts must be constant throughout the time period in question. This last condition was not met in our particular case. Although the Augustine event counts for January-April 1999 were much lower than the corresponding values for September-December 1998, the station from which the event counts were made was not constant. Station, AUS was used for the event counts during September-December but as the operation of this station became increasingly unreliable it was eventually replaced with another station for the counts. The change in the number of counts on the Helicorder plots is probably a reflection of a change in the stations used to make the counts rather than an actual decrease in the level of seismicity. An actual decrease in the level of seismicity at Augustine is still possible, but the apparent decrease in activity is more likely to be an artifact of station outages.

Volcano/Region	Nov-Dec'98	Jan-Feb'99	March-Apr 99	Predicted from the Mean Seismicity Rate
Entire Map Area	311	113	79	168
Griggs	0	0	0	0
Katmai	14	14	2	18
Mageik	121	22	13	31
Martin	103	47	49	62
Martin/Mageik	224	69	62	93
Novarupta	33	7	5	26
Snowy Mountain	0	0	0	1
Trident	8	10	1	7
Off-axis		13	9	—

Katmai:

January-February 1999:

A total of 113 earthquakes were located in the Katmai/Valley of Ten Thousand Smokes region during January-February 1999 (figs. 13a, 18a, 26a and 27a). The largest of these events had a magnitude of M_L=2.0 and was located at Martin and had a hypocentral depth of about 3 km. The earthquakes were assigned to the various volcanoes based upon their relative distances (as determined using the NEAREST program) from the respective volcanoes. Events located within 5 km of a volcano were designated as being associated with that volcano, unless, of course, the events were located closer to another volcano in which case the event would be assigned to the closer of the two. Of the 113 earthquakes located in the general Katmai/Valley of Ten Thousand Smokes region, 100 were designated as being associated with volcanoes. The number of earthquakes associated with each of the volcanoes is summarized in Table 1.

Ten of the 13 unassigned events were located well off the volcanic axis and are probably regional tectonic earthquakes unrelated to volcanic activity in this region. The remaining three unassigned events were located much closer to the volcanoes and are probably still volcanic events but may have been slightly mislocated.

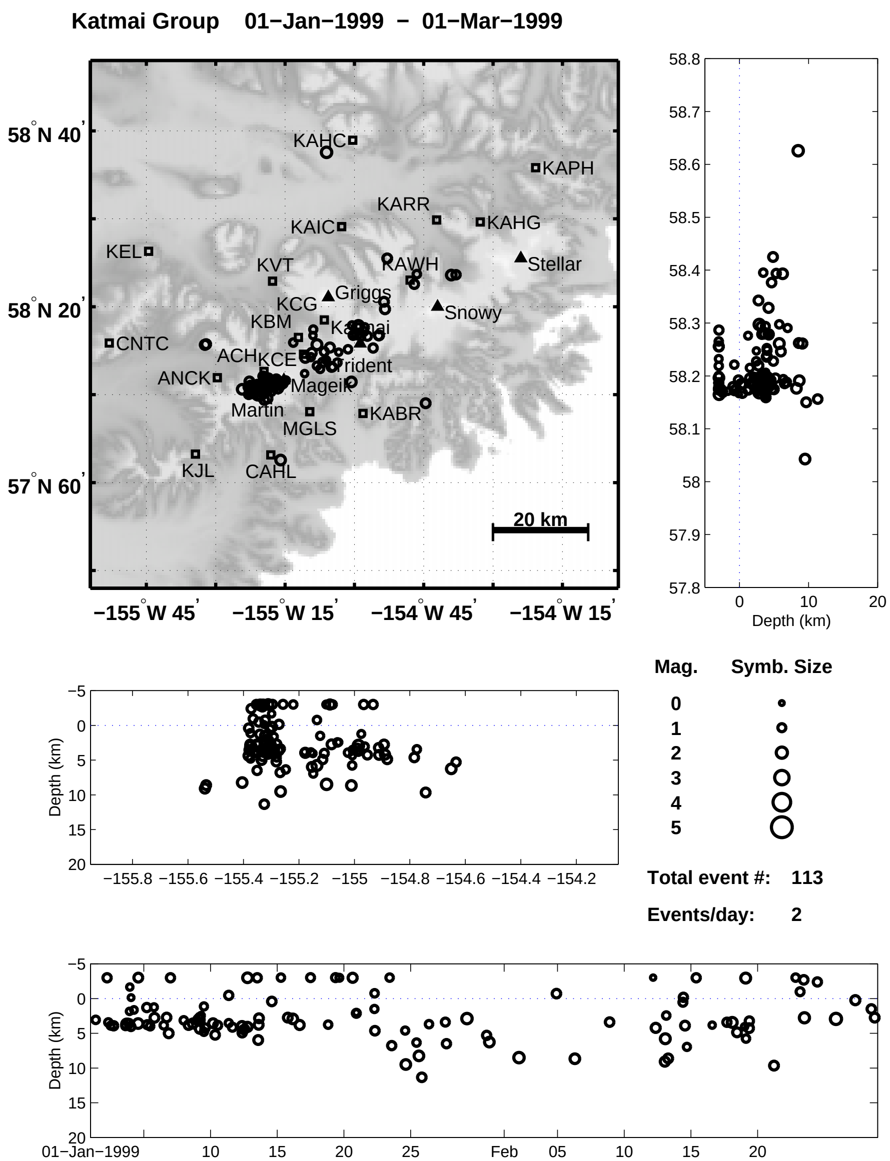

Figure 13a: Locatable Katmai group seismic events in space and time for January through February.

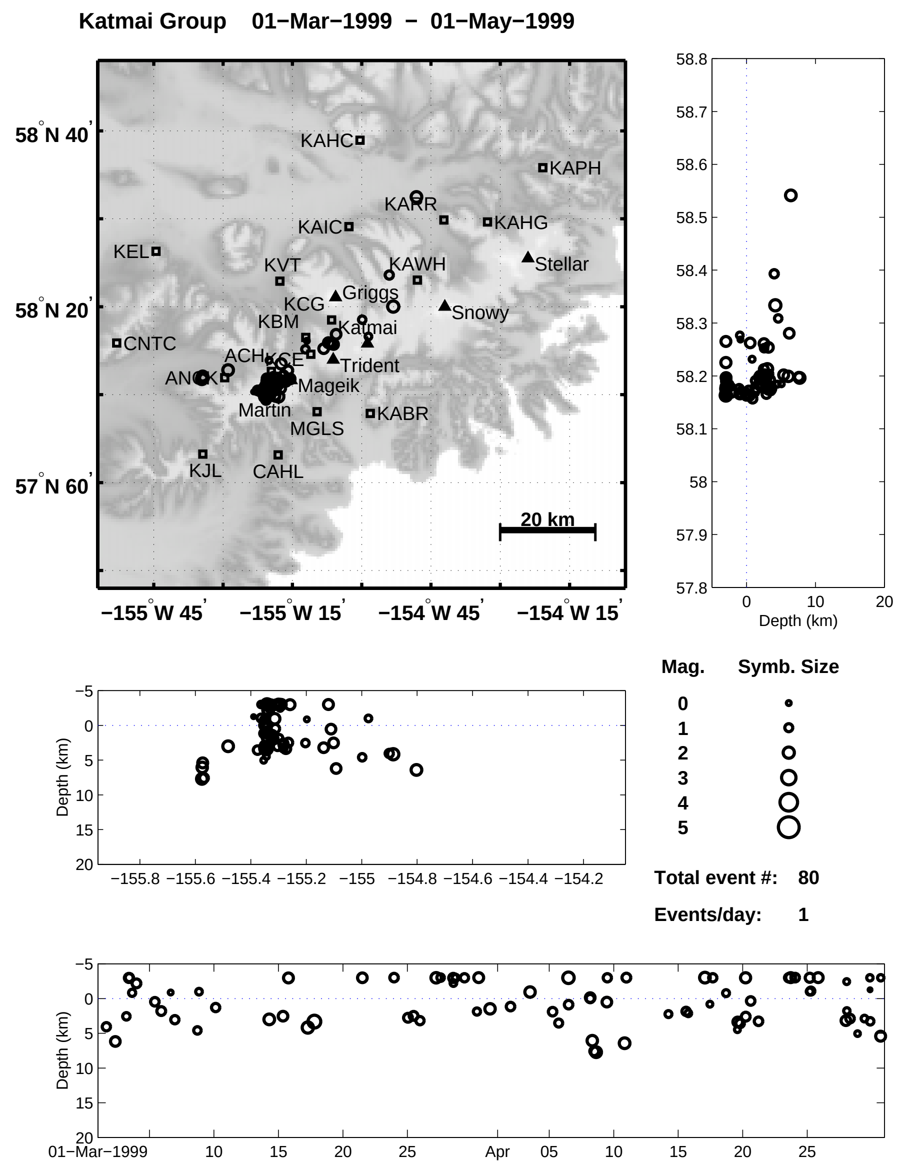

Figure 13b: Locatable Katmai Group seismic events in space and time for March through April.

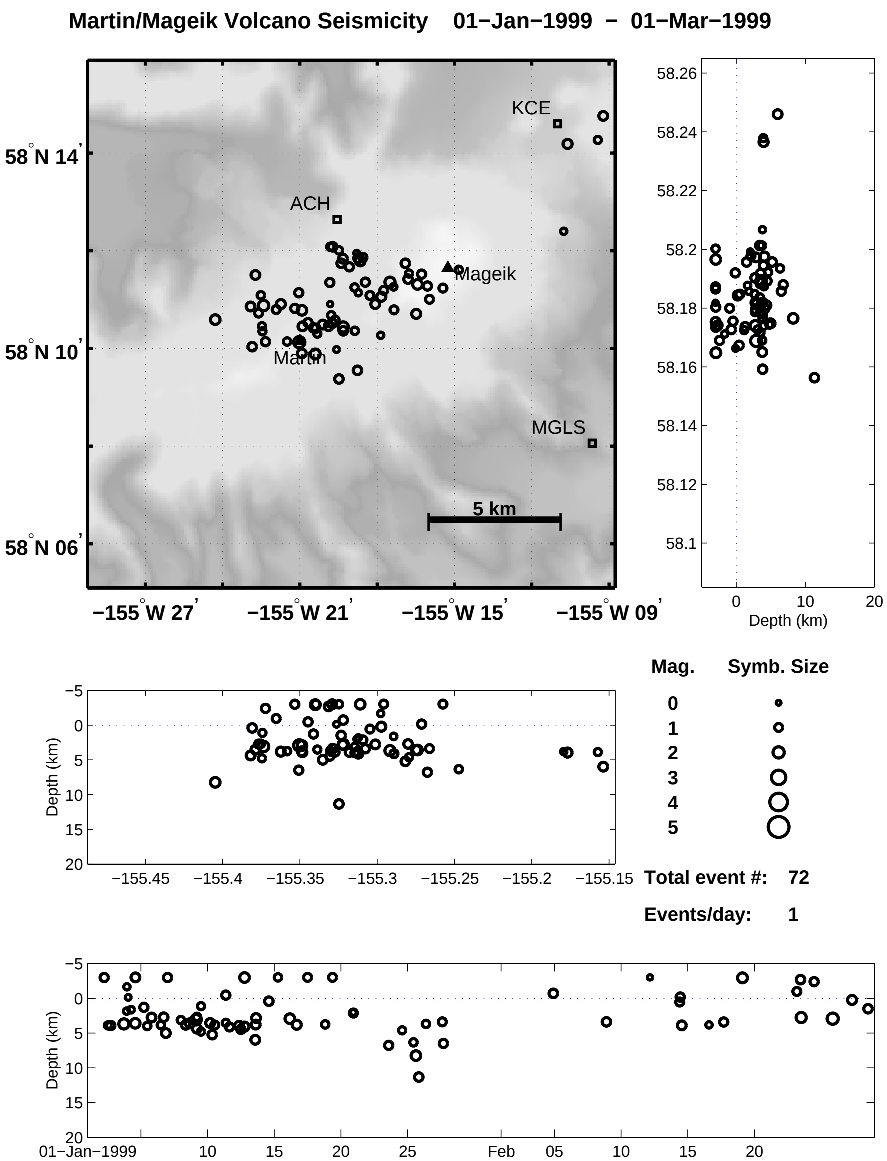

Figure 14a: Locatable Martin/Mageik seismic events in space and time for January through February.

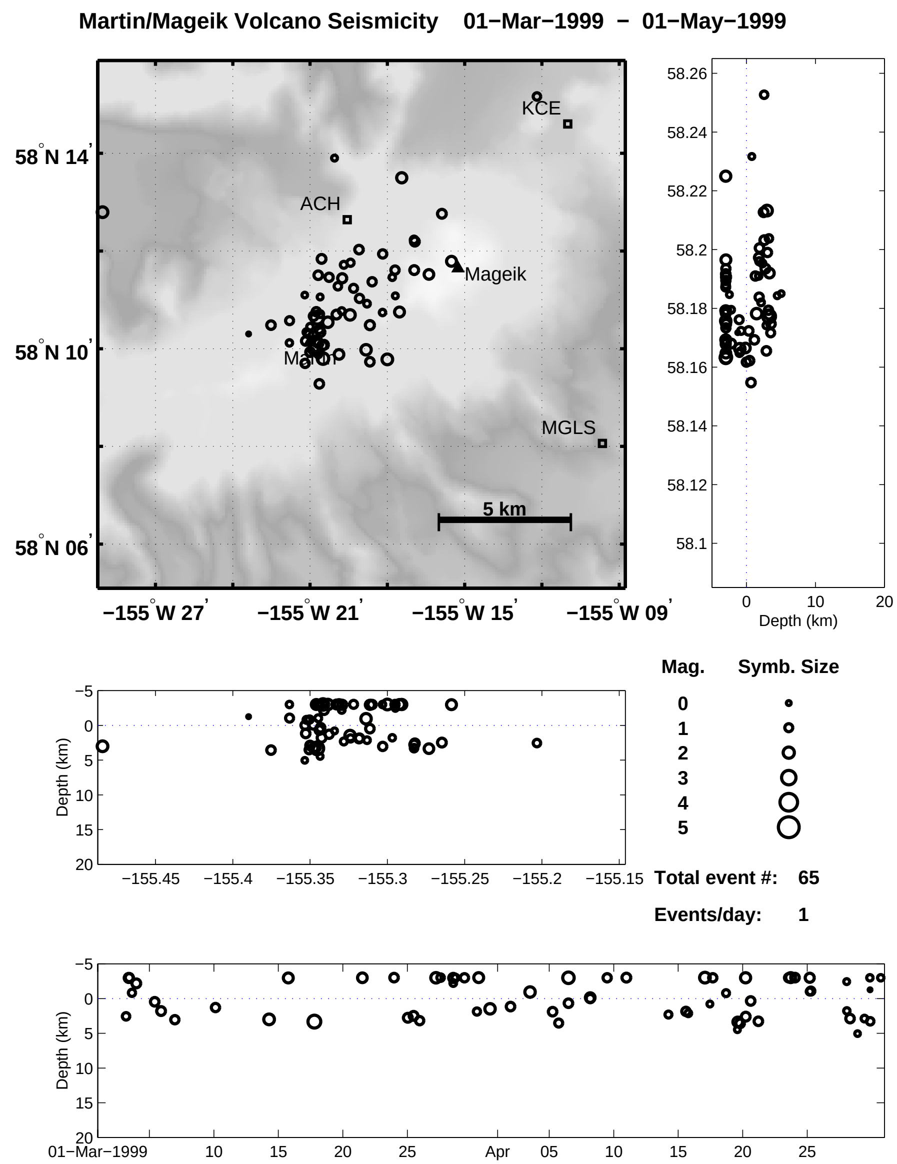

Figure 14b: Locatable Martin/Mageik seismic events in space and time for March through April.

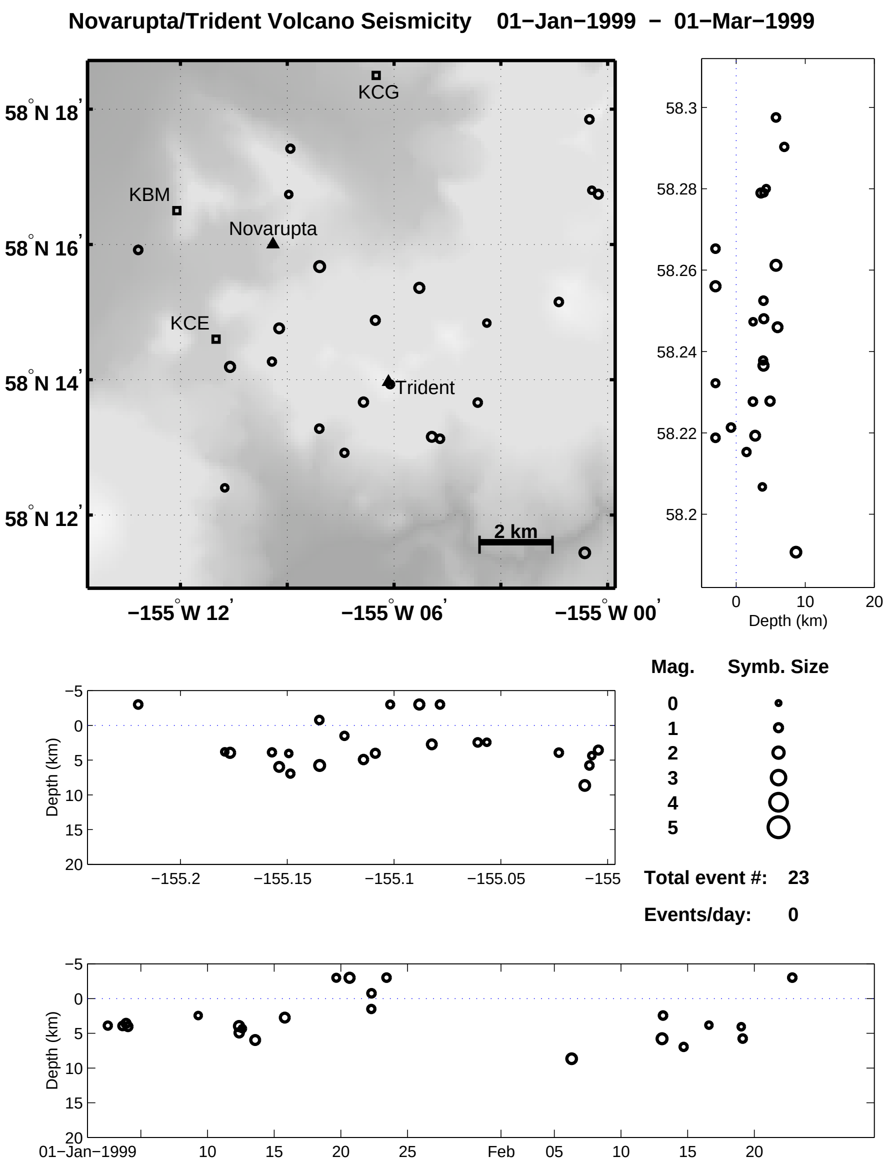

Figure 15a: Locatable Novarupta/Trident seismic events in space and time for January through February.

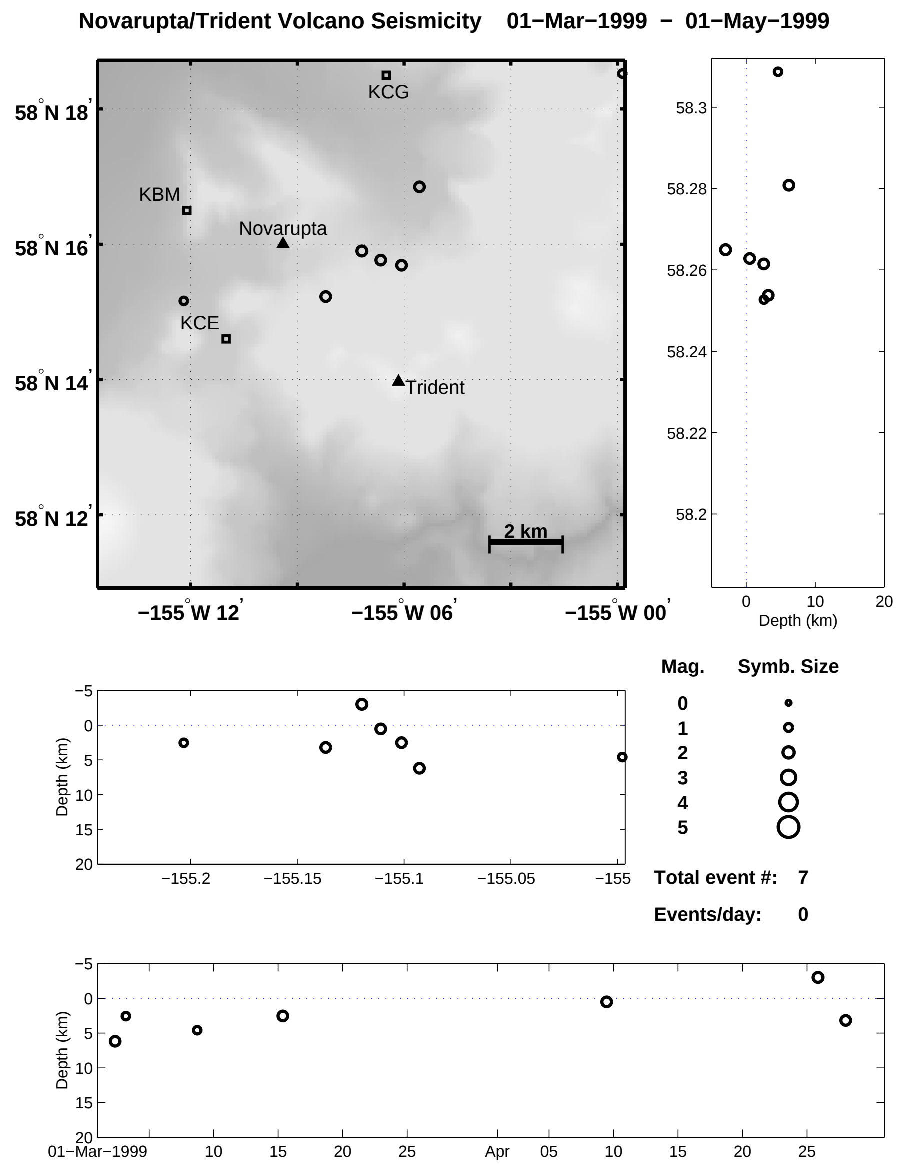

Figure 15b: Locatable Novarupta/Trident seismic events in space and time for March through April.

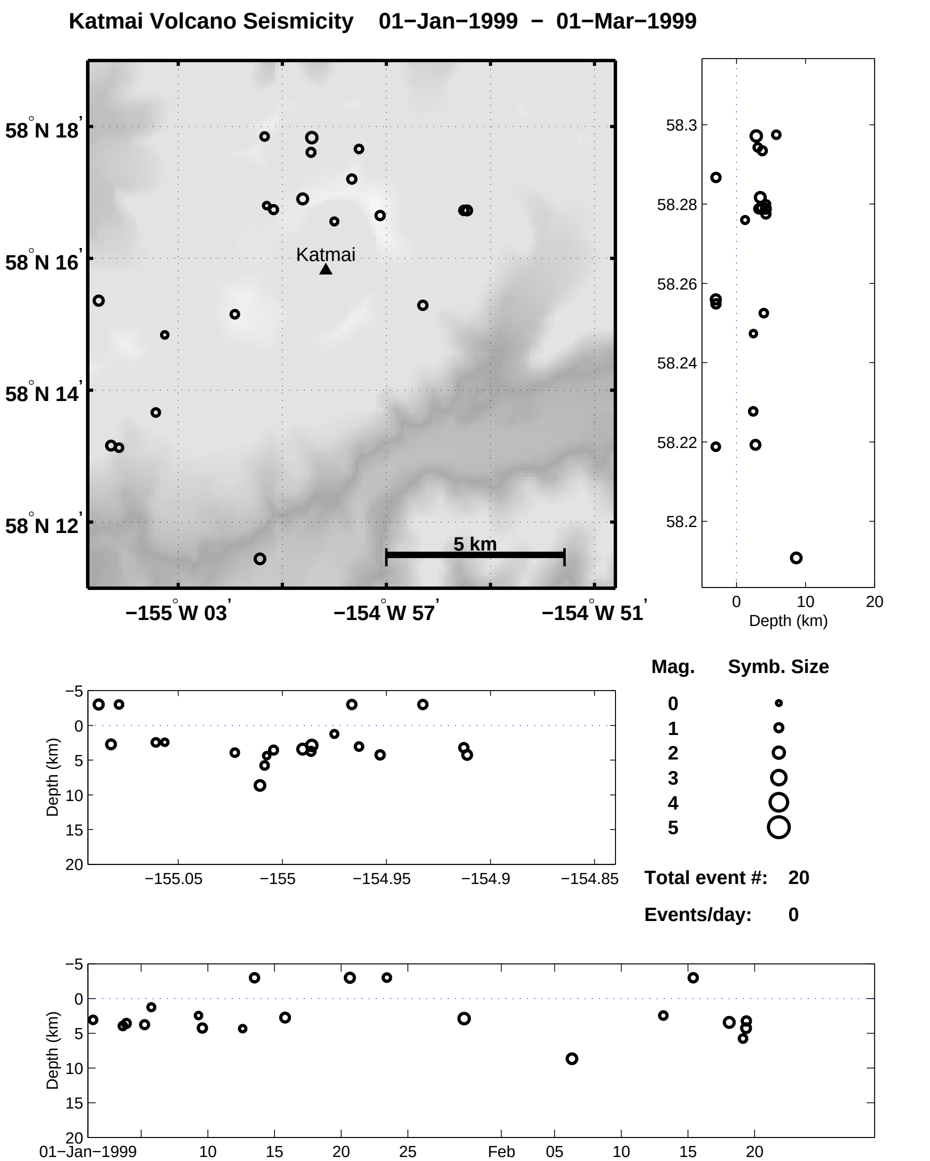

Figure 16a: Locatable Katmai Volcano seismic events in space and time for January through February.

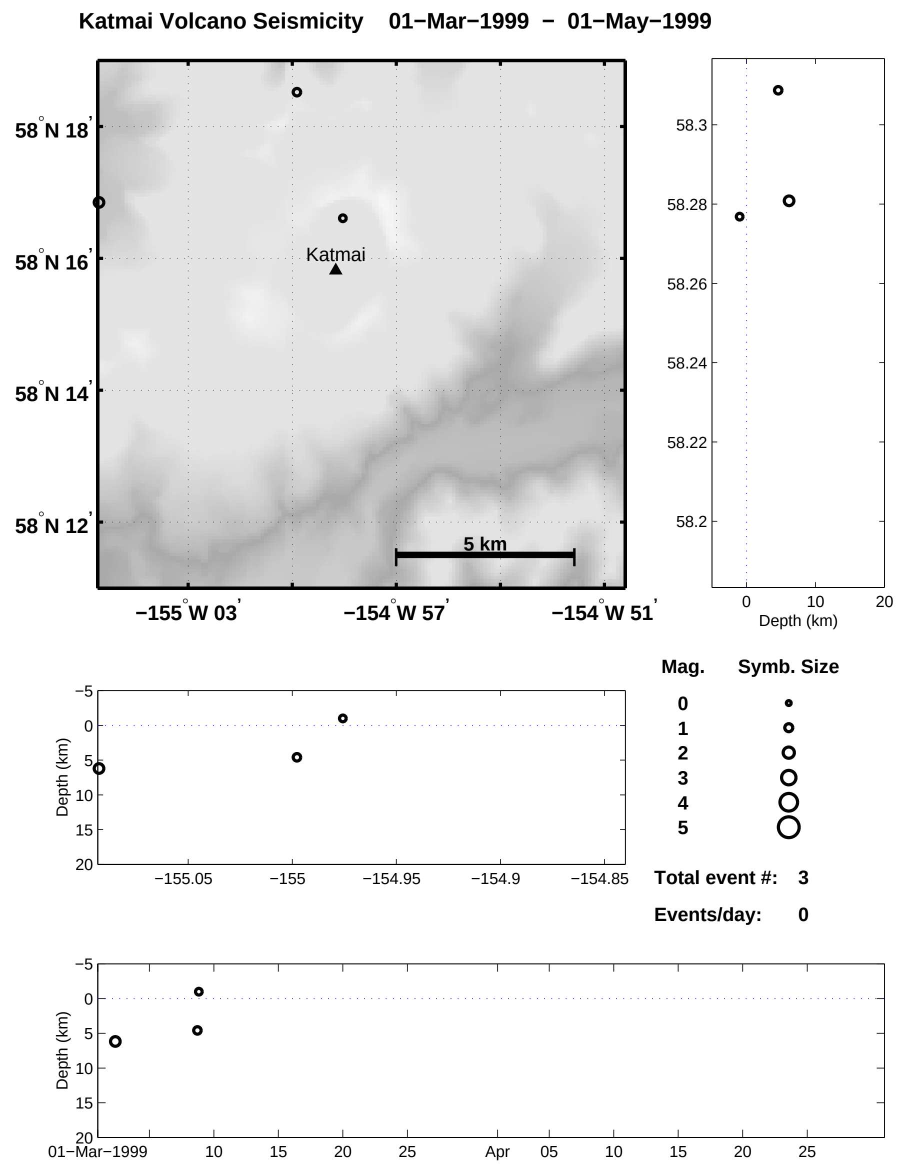

Figure 16b: Locatable Katmai Volcano seismic events in space and time for March through April.

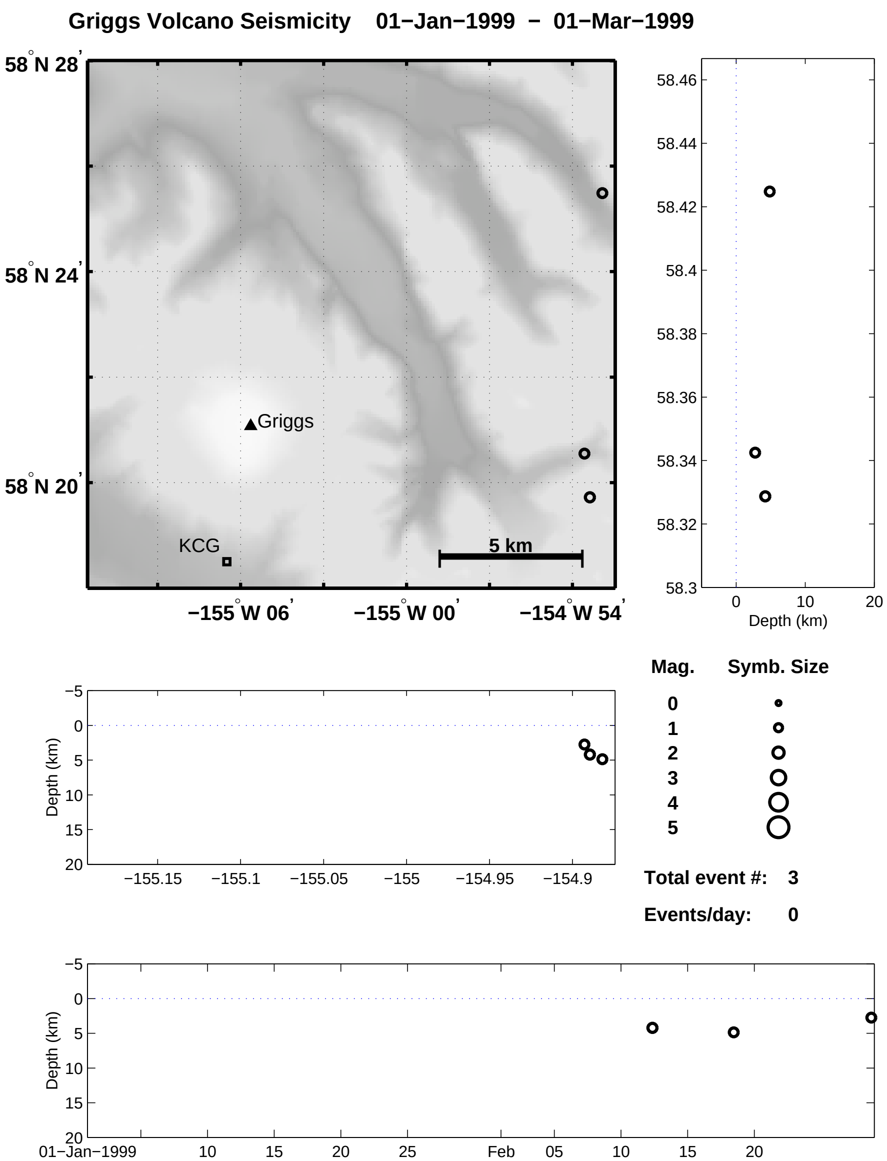

Figure 17a: Locatable Griggs seismic events in space and time for January through February.

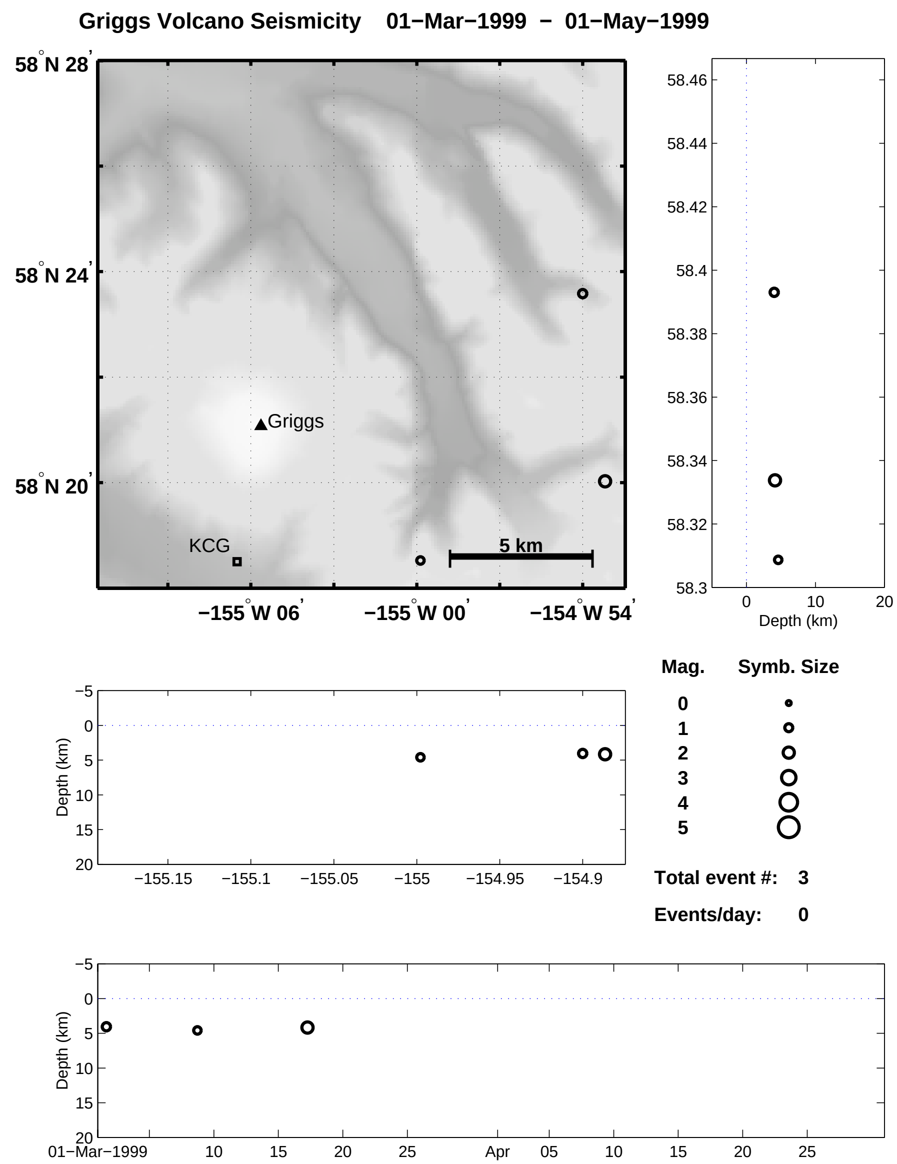

Figure 17b: Locatable Griggs seismic events in space and time for March through April.

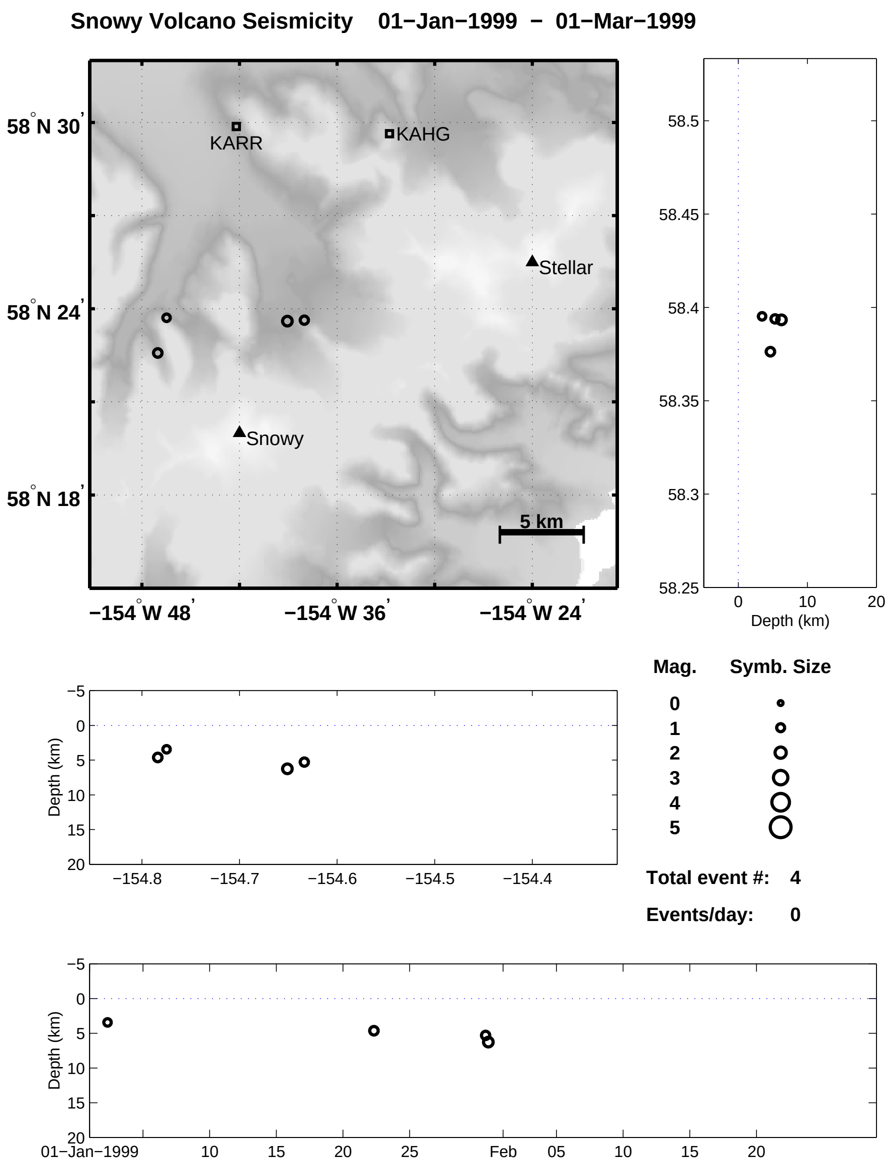

Figure 18a: Locatable Snowy/Stellar seismic events in space and time for January through February.

During January-February the number of events located in the entire region shown in figure 6A was much lower than that of the previous two-month period. The same can also be said of the number of events located in the Martin/Mageik region and near Novarupta. Comparison of the current level of seismicity with that of November-December is not entirely valid since there appeared to have been a seismic swarm in the Martin/Mageik area during that time (see the September-December 1998 Bimonthly Report). However, the number of Martin/Mageik events predicted from the Katmai mean seismicity rate was still much greater than that for January-February. The number of Novarupta events was also much lower than the predicted value. The same can be said of the total number of events located in the region shown in figure 15a. The relatively low number of located events during this two-month period appears to be the result of station outages. Affecting the entire region was an outage in which most of the Katmai network was out 8 of the first 11 days in February. Station CAHL stopped operating at the beginning of January and was out all of February, March and nearly all of April. MGLS was operational about the first ten days in January and continued to be out until the end of April. The loss of both these stations had an adverse effect on the detection and location of seismicity, particularly in the Martin/Mageik region and to a lesser extent in the Novarupta area. Another critical station with respect to monitoring the Martin/Mageik seismicity was ACH. ACH was out most of January and was out about half of February, March and April. KBM was critical to monitoring the activity at Novarupta. This station stopped operating at the end of January. Although KBM started operating again about the third week of February, this good fortune only lasted about a week after which KBM was out for the remainder of February and all of March and April. Also important to the monitoring of the seismicity at Novarupta was KCG. This station was operational all but the last three days in January. KCG was out about half the February and March and was out nearly the entire month of April.

March-April 1999:

During March-April 1999 a total of 79 earthquakes, the largest of which had a magnitude of M_L=2.5, were located within the Katmai/Valley of Ten Thousand Smokes region (figs. 13b-17b, 26b and 27b). The M_L=2.5 event was located about 1 km north-northeast of Martin and had a hypocentral depth of about 3 km. Earthquakes were once again assigned to the various volcanoes on the basis of epicentral distances. Seventy of these events were designated as being associated with one of the various volcanoes in this region. The number of earthquakes associated with each volcano is summarized above in Table 1. Of the nine non-designated earthquakes, eight (half of which were located in a tight cluster 13-14 km north-northwest of Martin) were located well off the main volcanic axis and thus are probably not volcanic in nature. The ninth event was located relatively close to Mageik and exceeded the 5 km cutoff by only 1.3 km. Due to its close proximity to Mageik it may still be related to volcanic activity in this area. The number of events located in the Katmai/Valley of Ten Thousand Smokes region during March-April was considerably lower than that of both the previous two-month period and the number of events predicted from the 16-month mean seismicity rate. This continued apparent decrease in activity was caused by the continued station outages noted above in the January-February discussion.