Preliminary Analysis of the 8 Aug. 2010 Zhouqu (Gansu, China) Mudslide by PALSAR Data and SAR Interferometry

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Under the Sentinel Asia framework, we acquired PALSAR data of JAXA's ALOS satellite over the Zhouqu (舟曲 in Chinese), Gansu, China area before and after the Aug. 8, 2010 mudslide event. By analysis of the SAR Interferometry (InSAR) coherence images before and after the disaster, we can identify those potential mudslides and those areas suffered from the Aug. 8, 2010 mudslide event. Because the optical images and high-resolution DEM unavailable, we do not do the joint analysis yet. The optical images may improve the current analysis using satellite radar data only. In addition, the SAR data analysis could be verified by field investigations so that we can exclude those areas, where there couldn't be slides.

The Sentinel Asia is a voluntary basis initiative led by the Asia-Pacific Regional Space Agency Forum (APRSAF) to support disaster management activity in the Asia-Pacific region by applying the WEB-GIS technology and space based technology, such as earth observation satellites data.

The data is acquired on 100508, 100623 and 100808 respectively. Note that the 100808 data is imaged at about 15:00 and the mudslide happened in the morning, so this data is acquired just few hours after the mudslide. The baselines of the InSAR pairs are less than 300~400 m. The 100808 data orbit is estimated and the other 2 images have precision orbit data available. All of the 3 images are FDB data. The InSAR coherence is high in all of the InSAR pairs because the temporal and spatial decorrelation is small in the data.

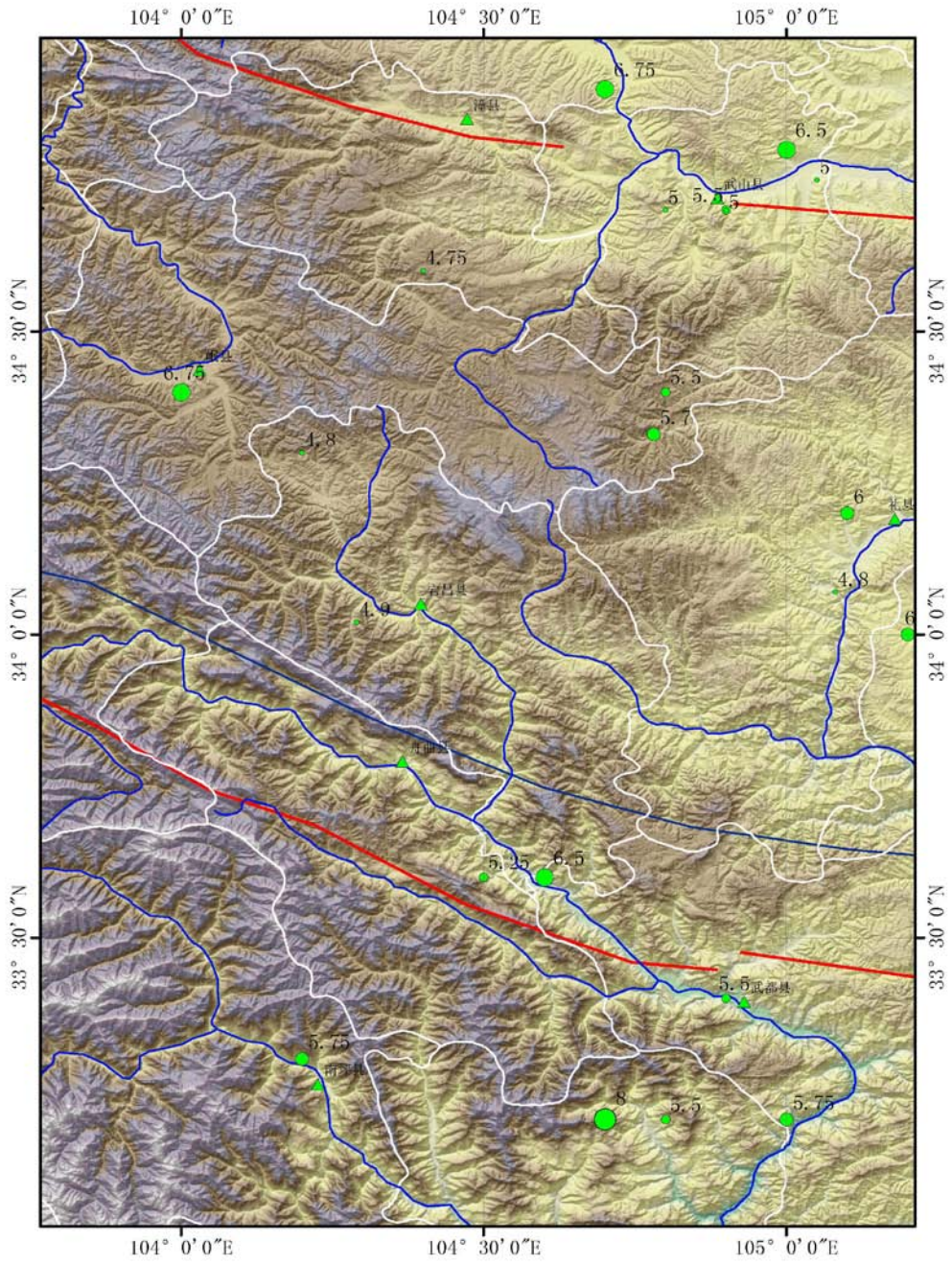

Figure1_DEM The SRTM 90m DEM is interpolated to ~30m. The white polygons are the county boundaries and the green triangles show the town locations. The light blue lines are rivers in this area. The red lines and deep blue lines are active faults across this area. The green filled circles show the locations of earthquakes happen around this area. The numbers beside the circles show the magnitudes of the earthquakes.

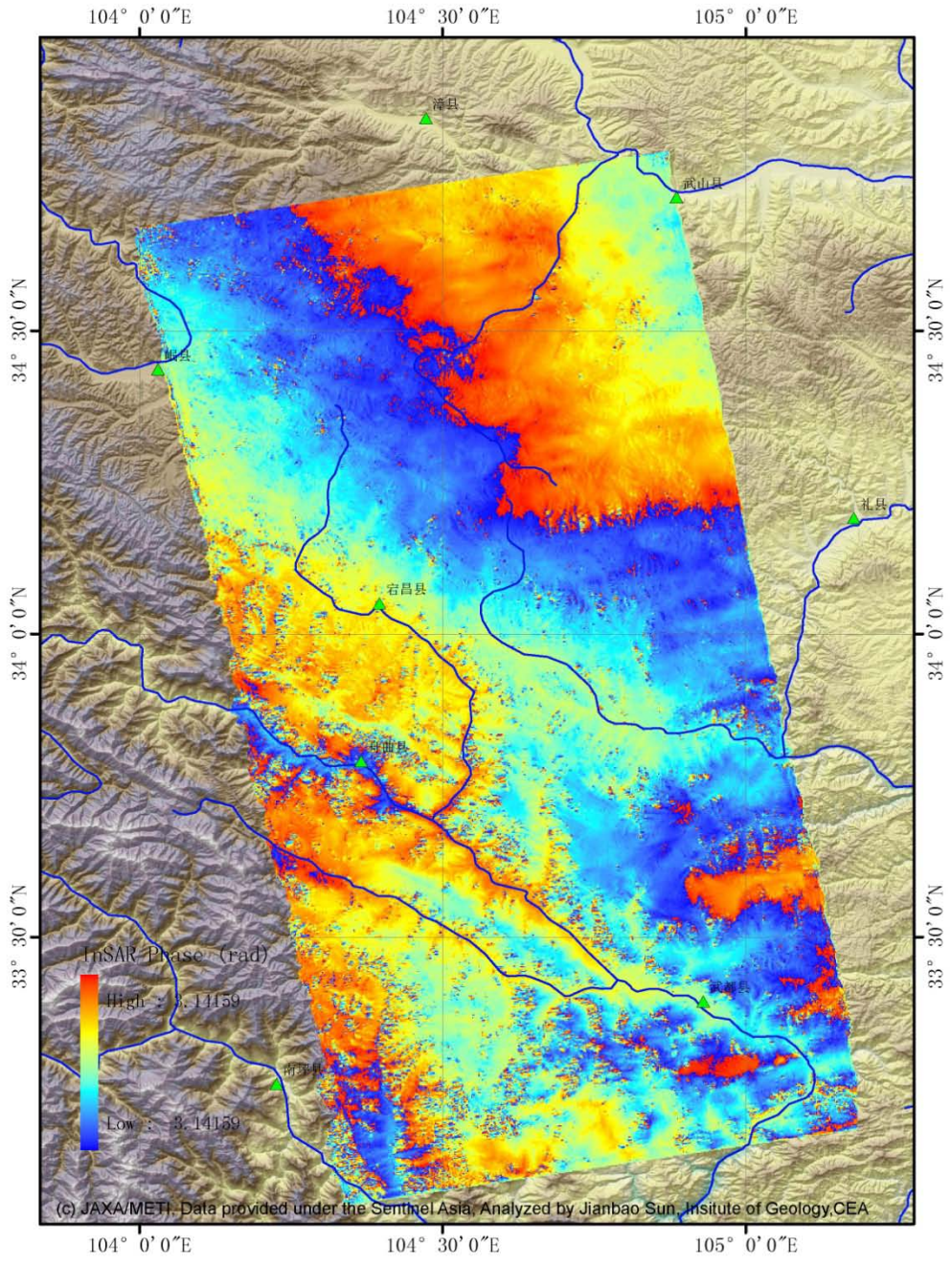

Figure2_HH100623-HH100808 The wrapped InSAR phase between 100623-100808 (FBD data in HH polarization). We can see some deformation along the river (Bailong Jiang) near the Zhouqu town. This may indicate the rain conditions induce some ground changes along the river during the imaging time interval, but we do not see any significant signals in the InSAR phase image maybe because the suffered area is very small compared with the whole image. The HV pairs do not show difference with the HH pairs.

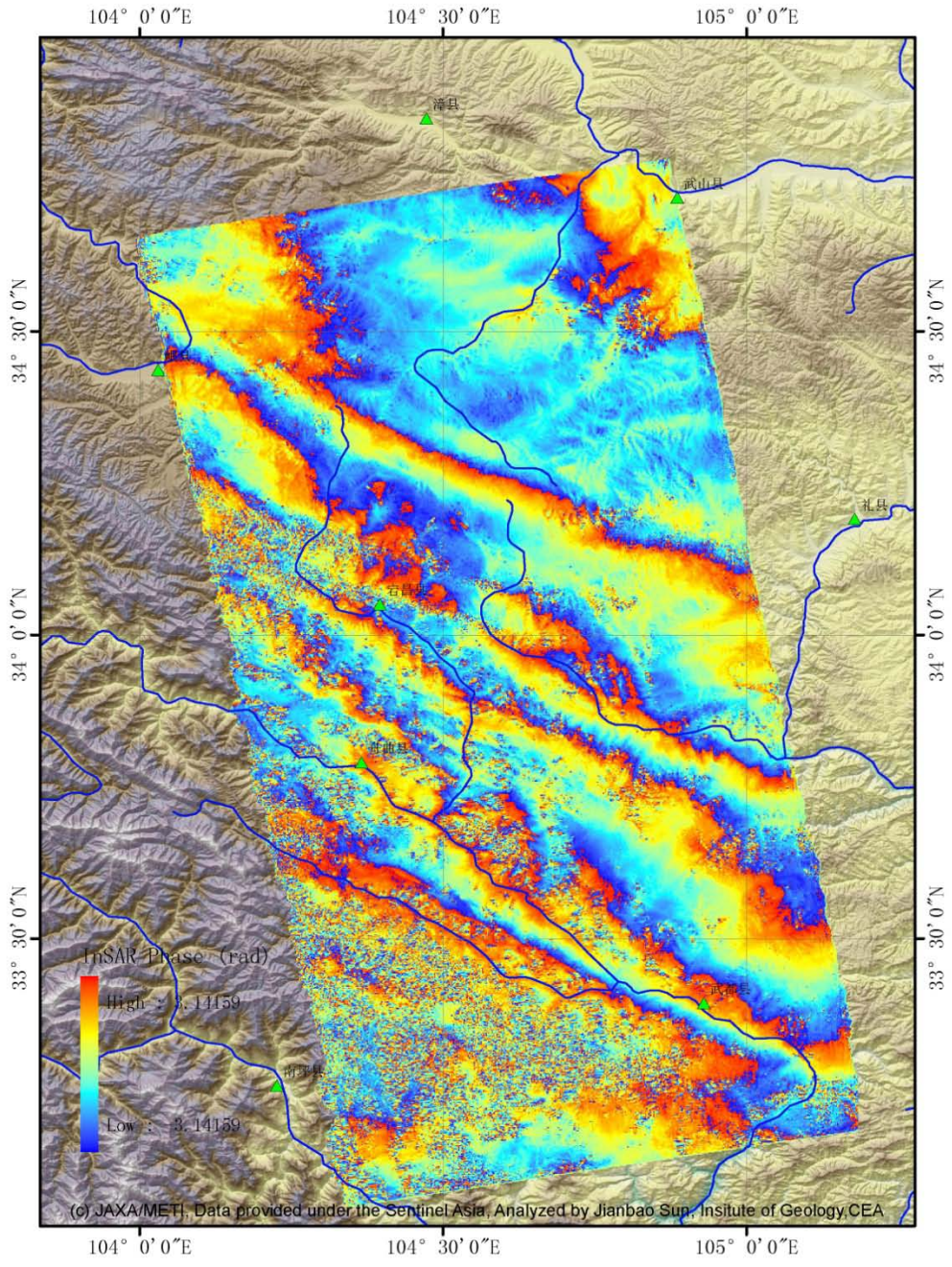

Figure3_HH100508-HH100808 The wrapped InSAR phase between 100508-100808 (FBD data in HH polarization). The InSAR phase image has many strips striking NW-SE. This shouldn't be any kind of deformation signals considering the short time interval of the data. We think this is the ionospheric delay of radar pulses in the imaging interval. In addition, the unknow orbit ramp may also have some contribution to the data noises.

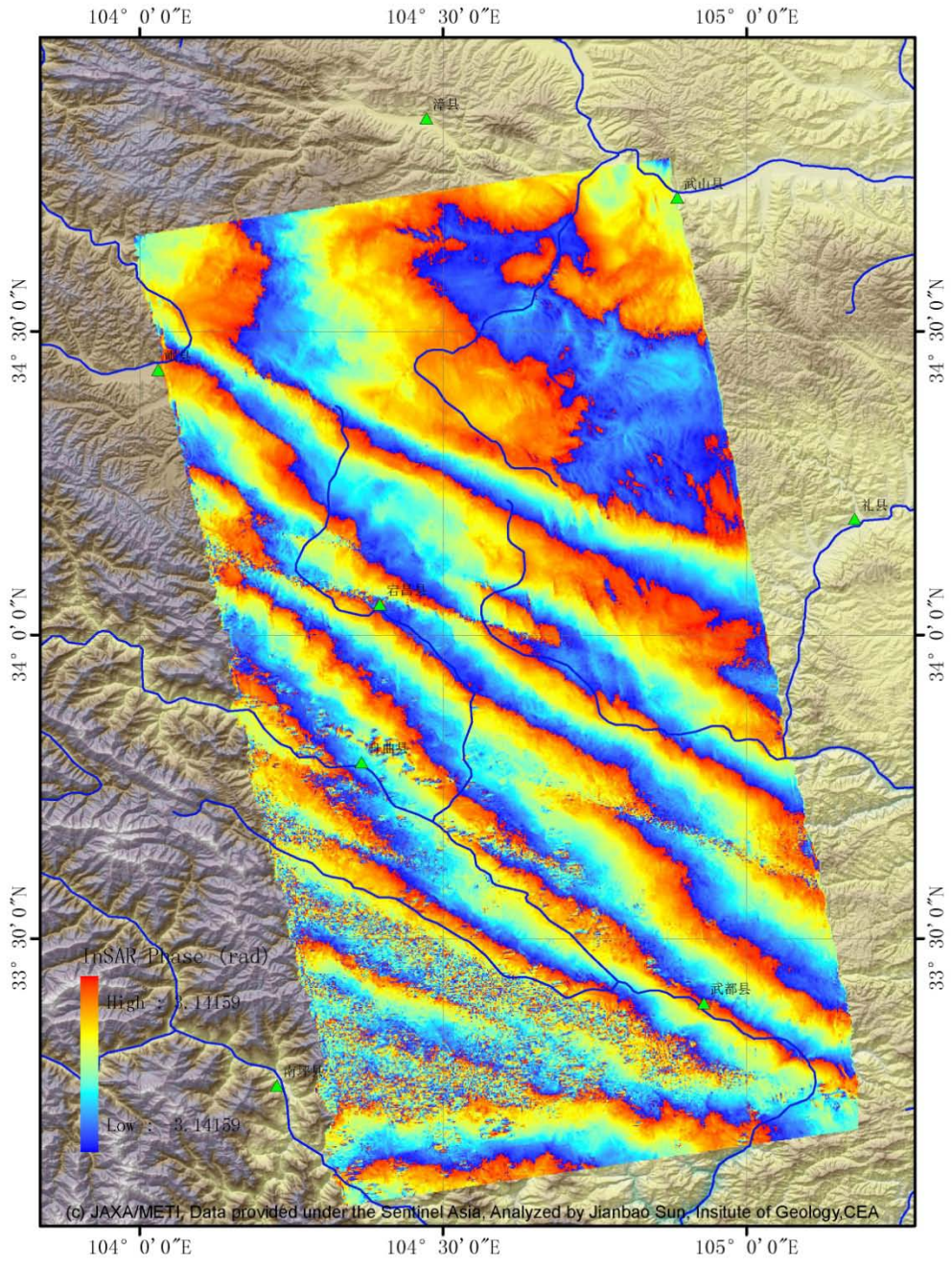

Figure4_HH100508-HH100623 The wrapped InSAR phase between 100508-100623 (FBD data in HH polarization). In order to investigate the ground situation before the mudslide, we also produced InSAR phase before the mudslide using the HH100508-HH100623 data pair. This data has same problem of the data pair in Figure3_HH100508-HH100808. So we infer that the 100508 data is disturbed by the ionosphere.

Now, we don't find any useful information from the InSAR phase. We use the InSAR coherence images to investigate the decorrelation of the data in different time intervals, especially the pre- and post-mudslide coherence images. This can give help to identify the potential mudslide areas

and the areas suffered from mudslide.

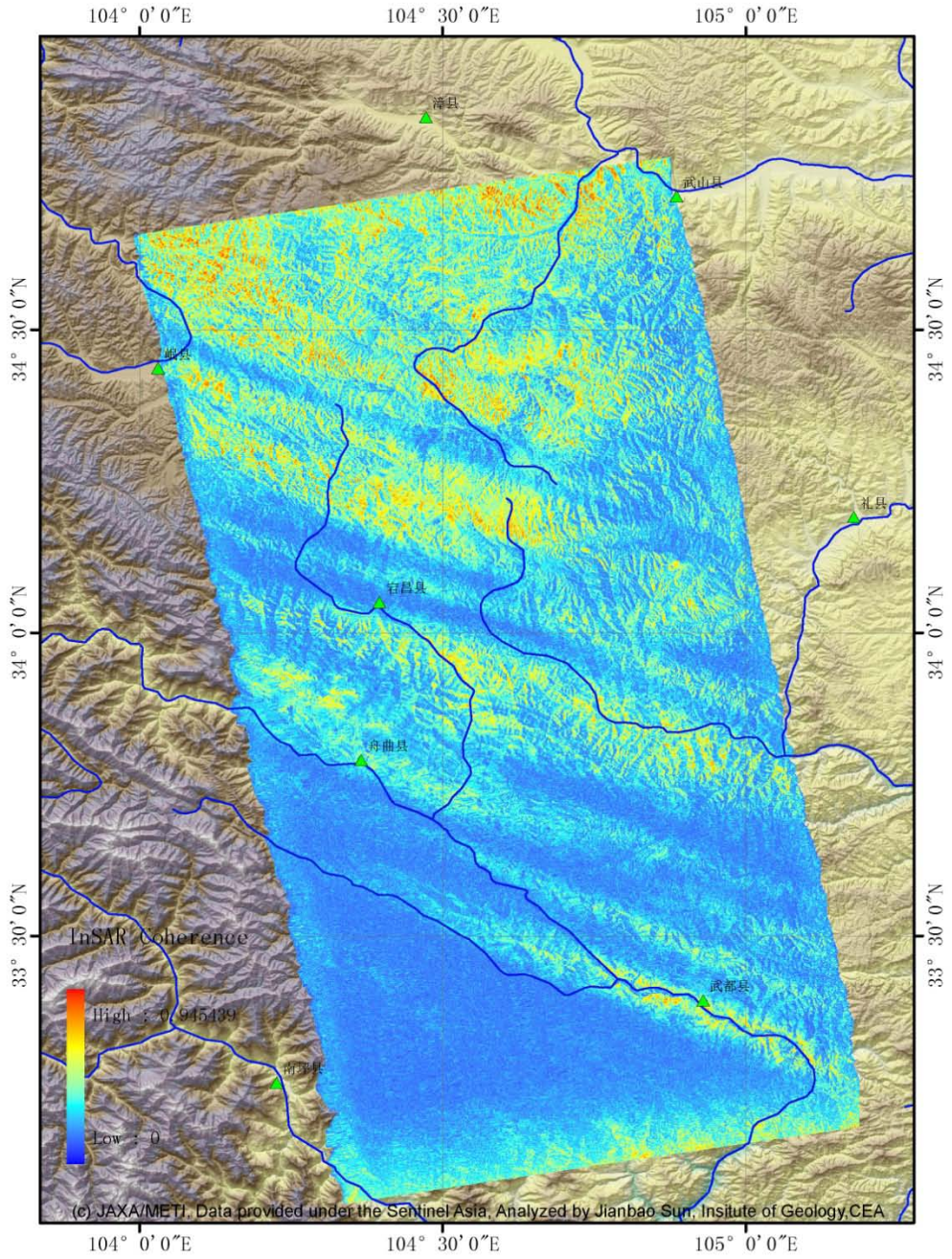

Figure5_HH100508-HH100623_COH The coherence map of the InSAR pair HH100508-HH100623. The pre-mudslide coherence image shows the same problem as the InSAR phase because the possible ionospheirc delay can lead to the decorrelation of InSAR data.

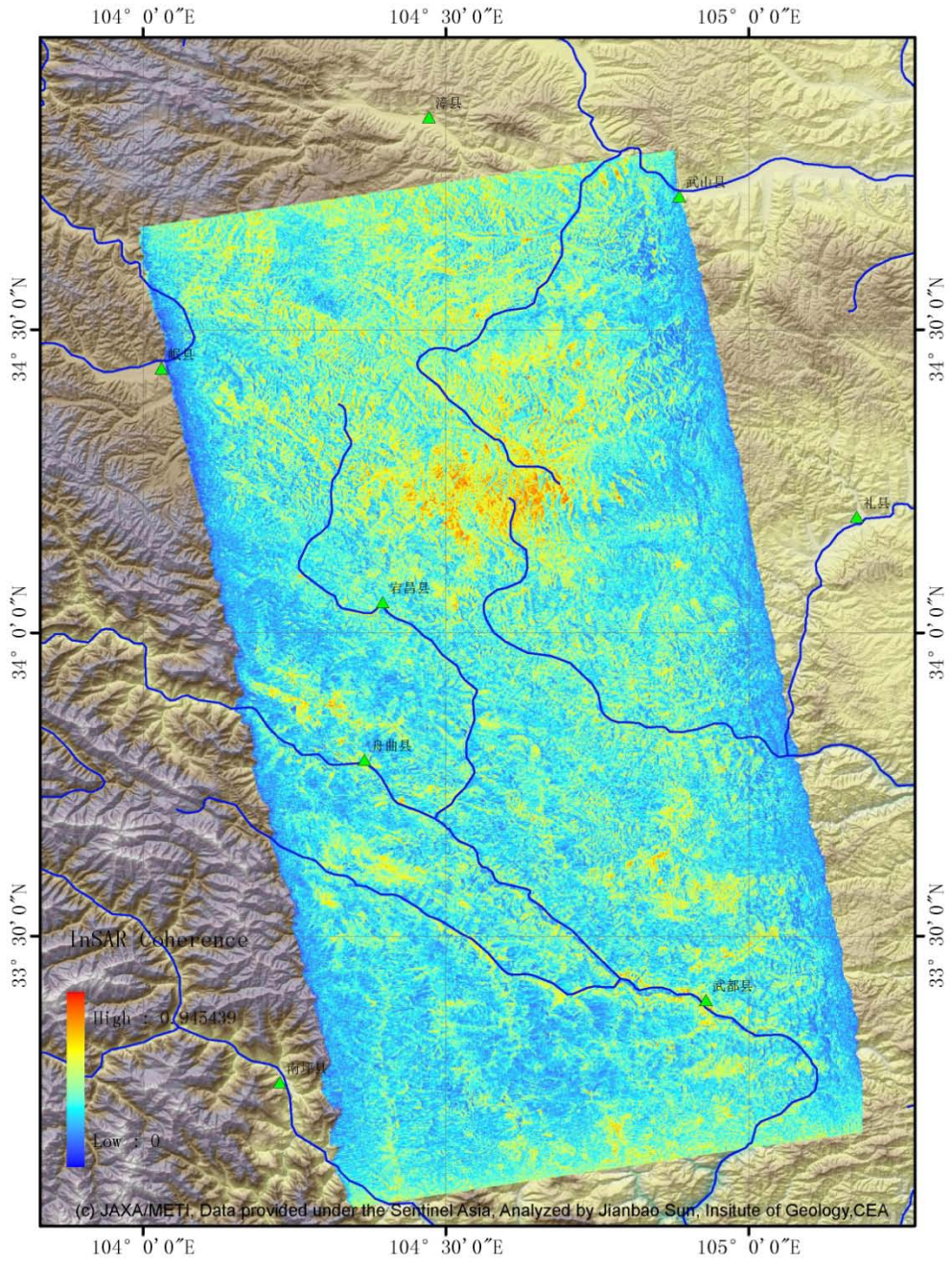

Figure6_HH100623-HH100808_COH The coherence map of the InSAR pair HH100623-HH100808.

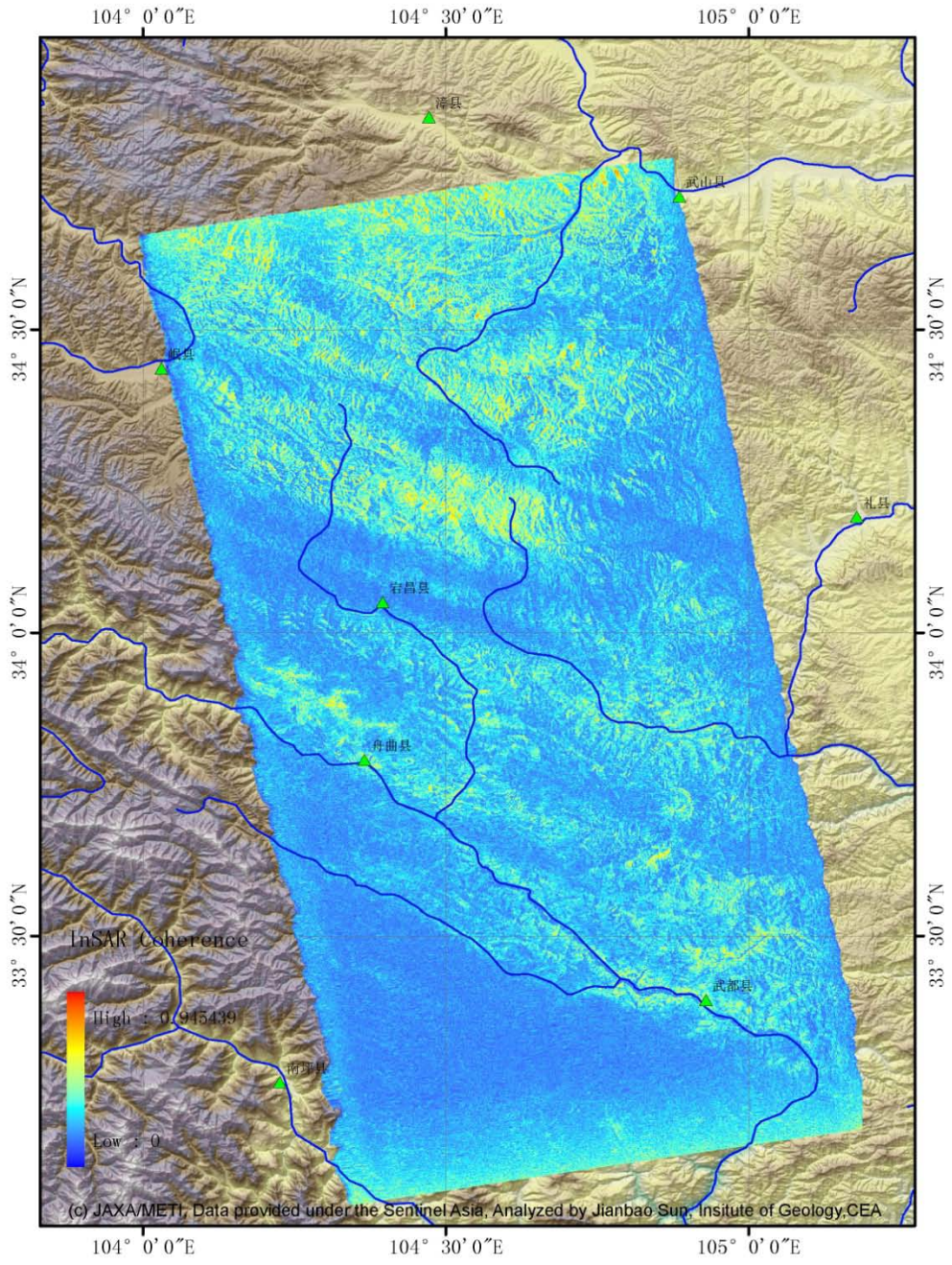

Figure7_HH100508-HH100808_COH The coherence map of the InSAR pair HH100508-HH100808.

In order to investigate the potential and suffered mudslide areas, we need to zoom in Figure 5, 6 and 7, so that we can look into the details of these images. Even though the whole image is not informative about the mudslide, we can get important information from the zoom-in images. We use these images to define the potential and suffered areas. But we declare that these images are extracted from PALSAR data only and we do not use optical images and high-resolution DEM to calibrate the results. The later may give help to exclude those areas which is not the mudslide sources. There are many reasons leading to InSAR decorrelation besides the temporal

decorrelation induced by the mudslide motion. Using other data sources, this can be analyzed easily. Another way to improve our results is to investigate the mudslide area and exclude those non-mudslide sources. This could be easy because the whole suffered area is very small.
We plot our defined mudslide sources on Google Earth so that the results can be used easily and wish it would be helpful for the disaster migrations.

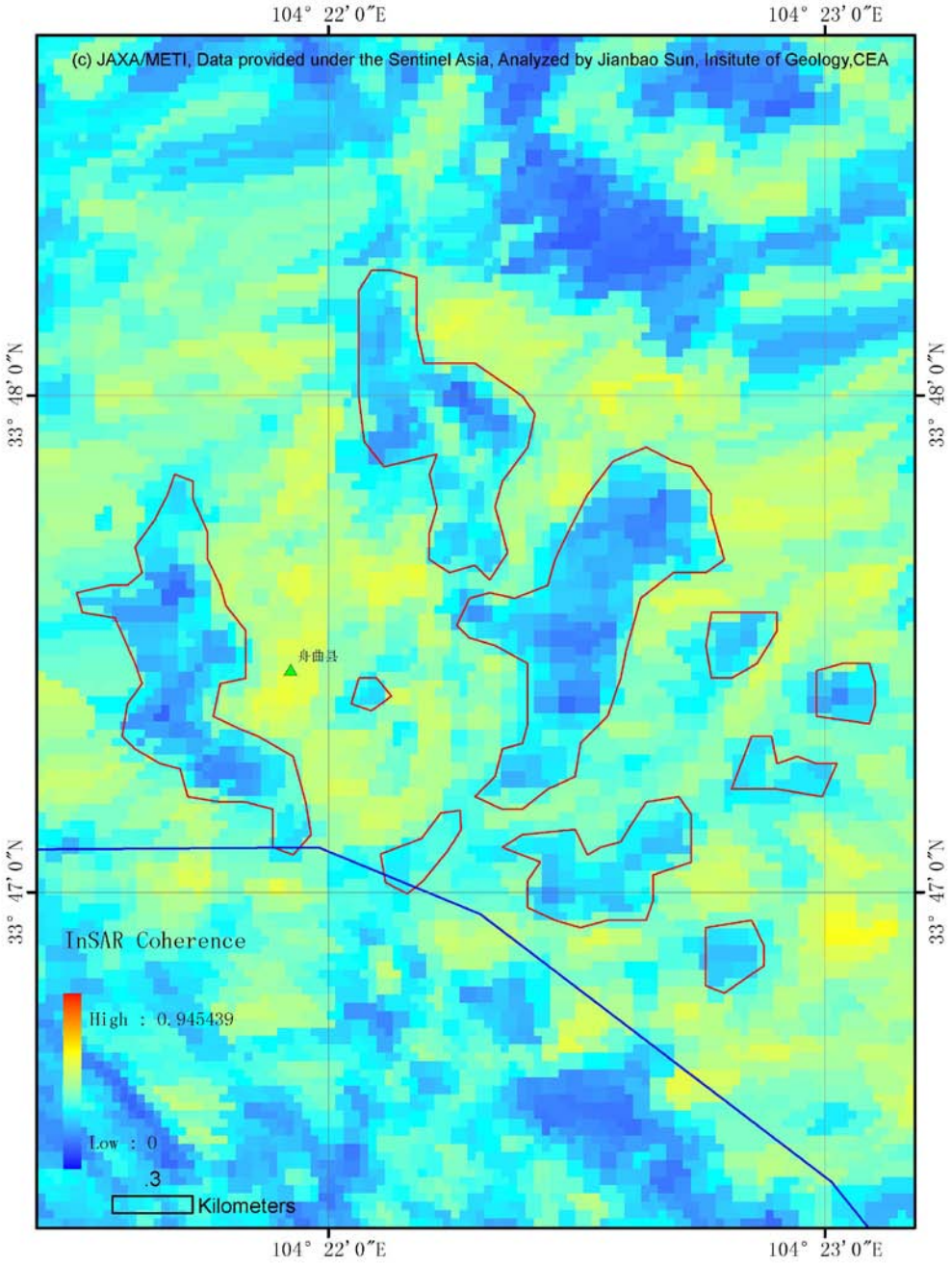

Figure5_HH100508-HH100623_COH_ZoomIn We mainly focus on the coherence image around the Zhouqu town (The green triangle) to look for the low coherence areas (blue color). We assume all of these areas suffered from (potential) mudslide. There are many other low correlation areas, but we do not identify these areas because it's far from the populated areas.

Near the Zhuqu town, the coherence is generally high (yellow areas). This helps separate the mudslide areas with the non-mudslide areas. The red polygons are the identified areas. Because the time interval of the data is 100508-100623, the identified areas may indicate that the mudslide source actually exist before the Aug. 8, 2010 mudslide event. Note that this could also originate from other ground changes, but in L-band radar data we believe much of the information deserves to be further investigated because the data can avoid the decorrelation of vegetation and farming to some extent.

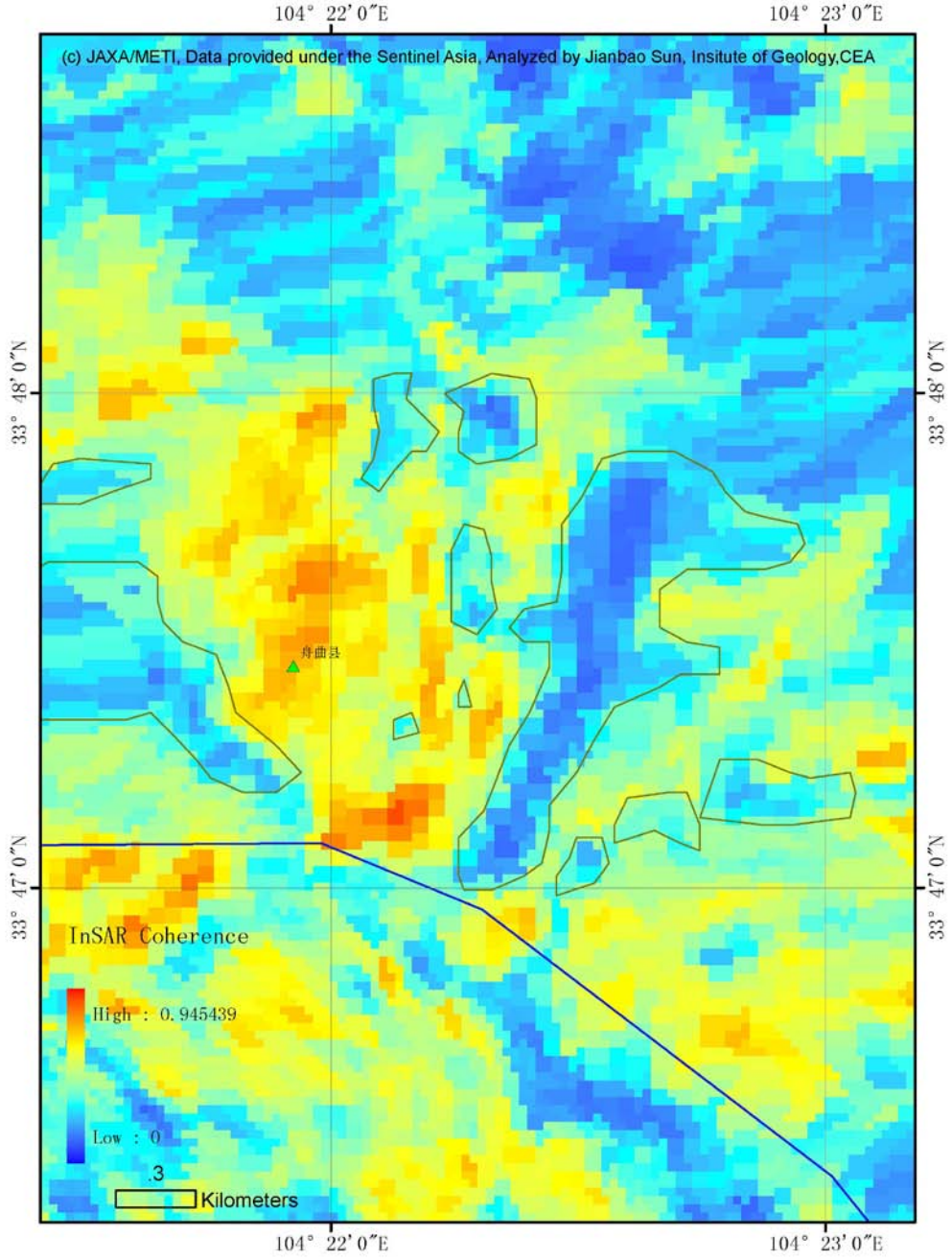

Figure6_HH100623-HH100808_COH_ZoomIn The coherence map of the InSAR pair HH100623-HH100808.

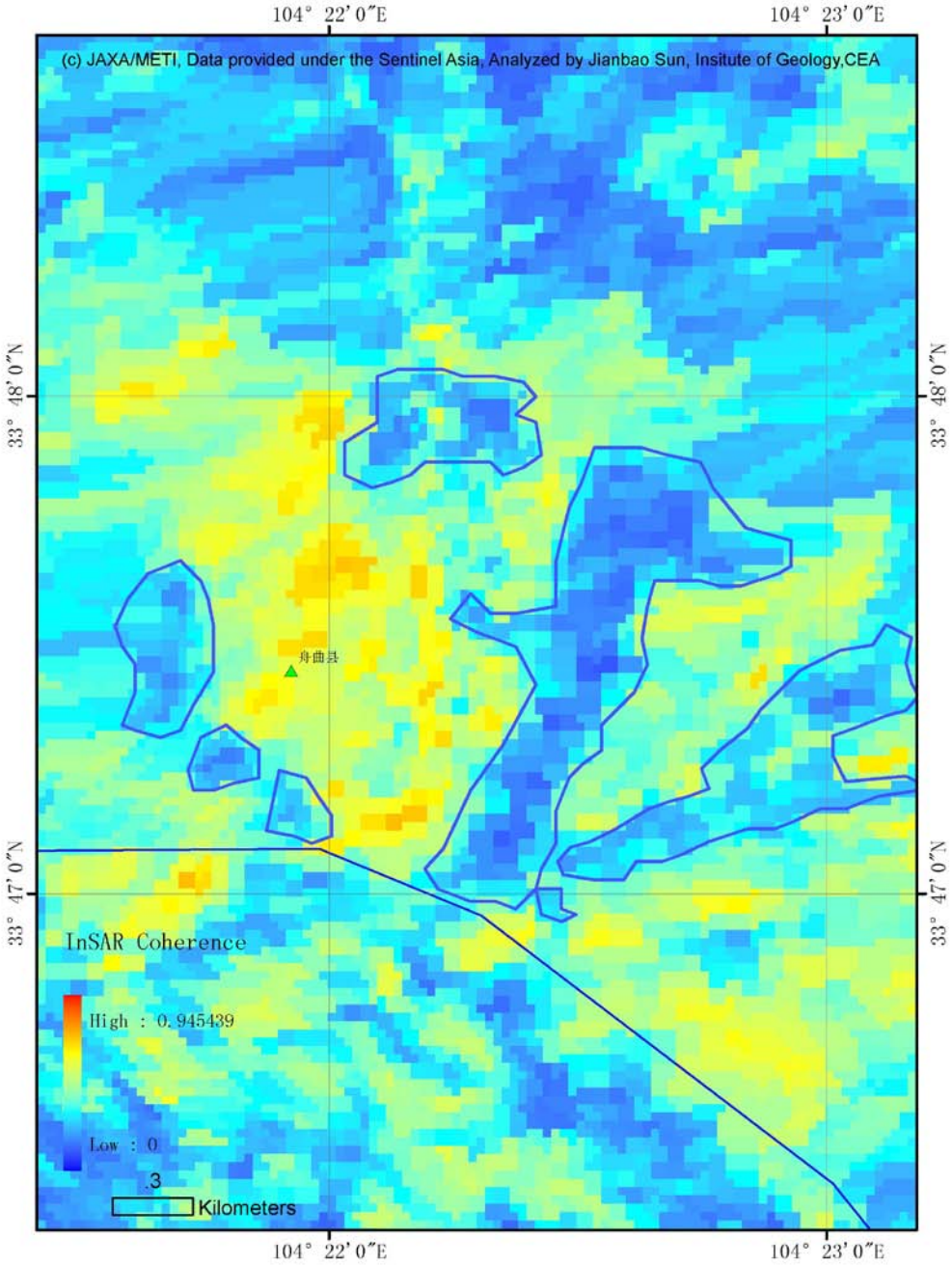

Figure7_HH100508-HH100808_COH_ZoomIn The coherence map of the InSAR pair HH100508-HH100808.

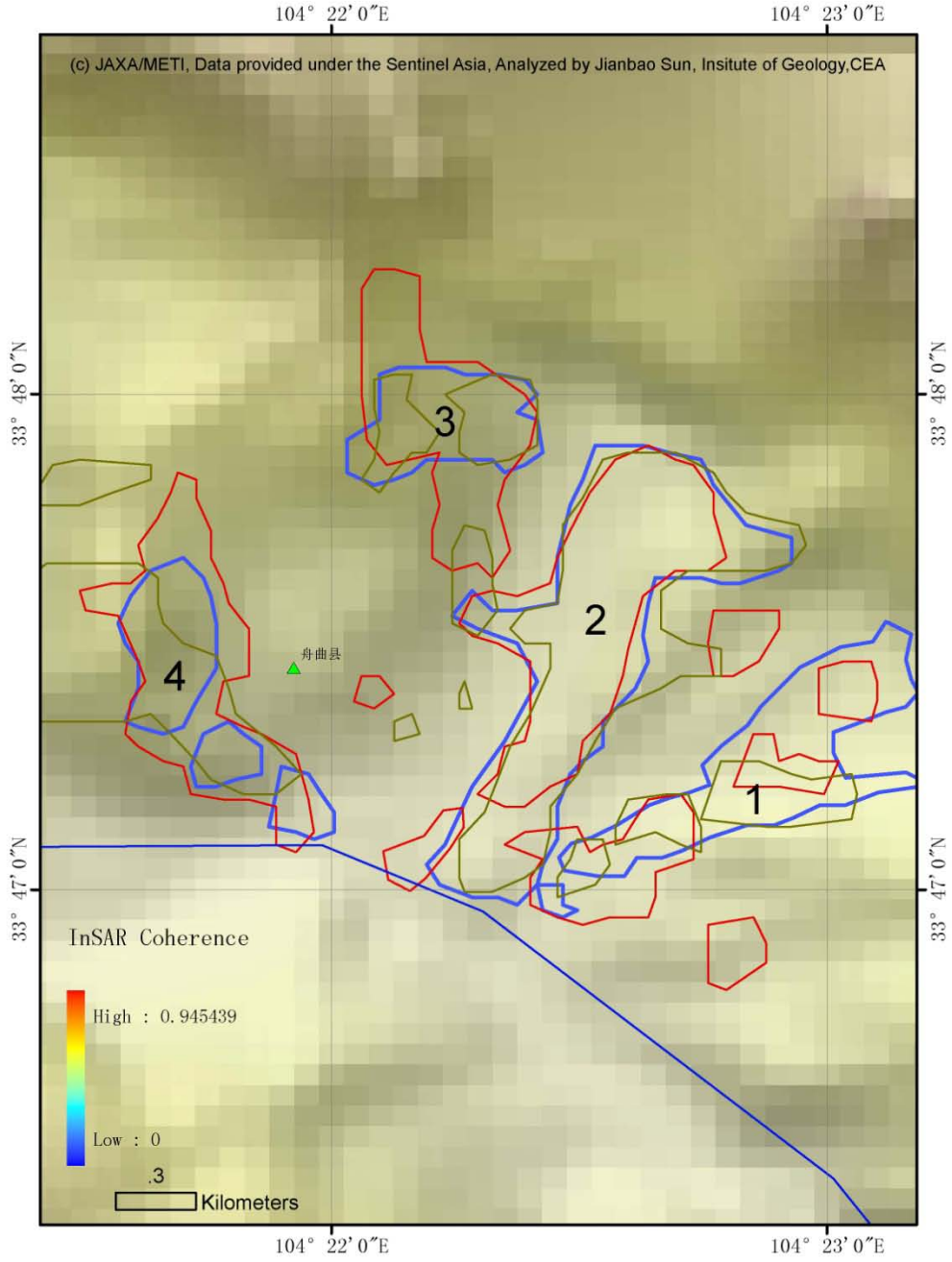

Figure8 The final analysis result. We plot the 3-polygon groups together (green, blue and red) and find that they are very consistent in spatial. We define the mudslide sources as 1~4. The source 1 is the Luojiayu mudslide and the source 2 is the Sanyanyu mudslide. These 2 sources had happened on Aug 8, 2010. Except these two sources, there are still 2 smaller potential mudslide sources, numbered 3 and 4. In Google Earth maps, we find that the two sources are just on two slopes. So this could be dangerous sources in the future if there are heavy rain occurred.