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RECENT ACTIVITY OF CHANGBAISHAN TIANCHI VOLCANO REVEALED BY TIME SERIES INSAR AND GEOPHYSICAL MODELING

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Abstract

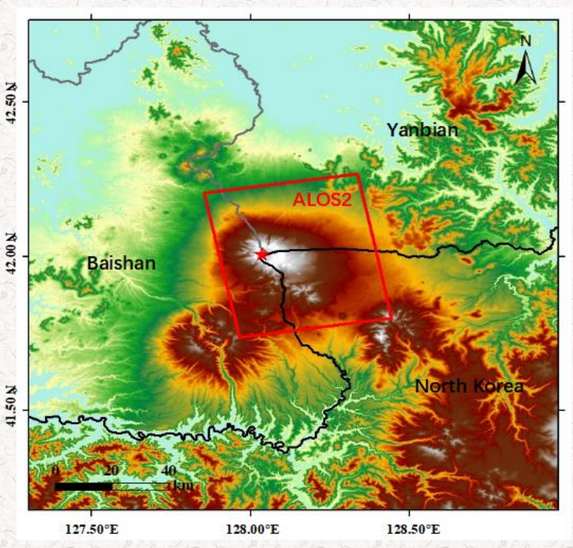
Changbaishan Tianchi volcano is located at the border of China and North Korea, which is the most active volcano with eruption potential in China. During the period from 2002 to 2005, the frequency and magnitude of seismicity in Tianchi volcano area increased significantly, indicating the volcanic activity entered an active period. After the active period, volcanic activity has returned to previous level. However, a volcanic swarm suddenly appeared on December 22, 2020, with 38 volcanic seismicity events of various types occurred. On March 5, 2021, another earthquake with magnitude of ML3.1 occurred, which is the largest VT (Volcanic-tectonic) type earthquake event after active volcanic disturbance period. These phenomena show that the volcanic seismic activity after December 2020 is beyond the background level, and monitoring of Tianchi volcano should be conducted continuously.

In this study, 19 ALOS-2 images from November 2018 to October 2020 were processed to estimate the surface deformation of Tianchi volcano area based on SBAS-InSAR technology[1]. Due to the large topographic inequality in the volcanic area, obvious vertical stratified atmospheric phase and topographic residual are detected and removed from the interferometric phase. The results show that the ground surface of Tianchi volcano is uplifting slightly during this period, and the closer to the crater, the more obvious the uplift. Geophysical modeling based on Mogi point source was also conducted using the SBAS-InSAR results, indicating a point source at the depth of approximately 4-6km[2]. The modeled depth is in agreement with the depth of seismic events, which is possibly where hydrothermal activity is happening in the shallow magma chamber. Generally, this study provides data support for the monitoring of volcanic activity and future disaster assessment in Changbaishan Tianchi volcano, and verifies the feasibility of time series InSAR and geophysical modeling in applications of active volcanoes.

Data processing and results

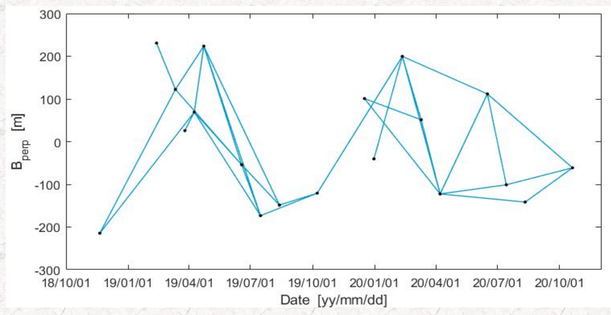
Study area

19 L-band ALOS2 images covering the study area from November 2018 to October 2020 were selected.

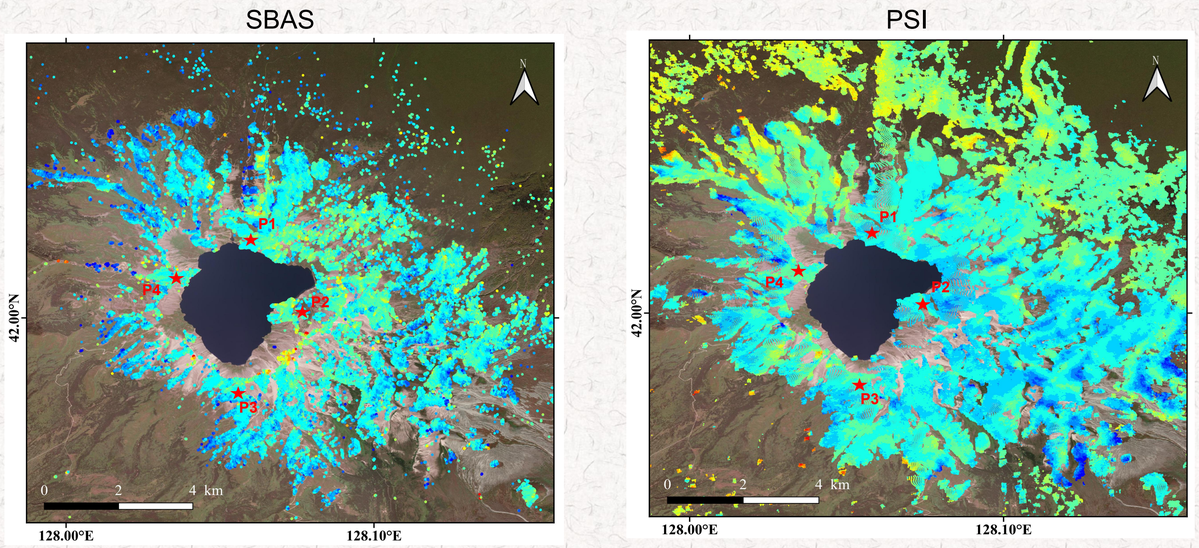


Method

- SBAS method is used to obtain the unwrapping phase of the interference pair.
- Using DEM and singular value estimation method, the phase of vertical stratified atmosphere is removed.
- The residual terrain phase is removed according to the oblique distance, vertical baseline and radar incidence angle.
- Phase to deformation.
- Mogi model is used to simulate the surface deformation caused by magmatic activity.



Cumulative deformation of satellite’s line of sight

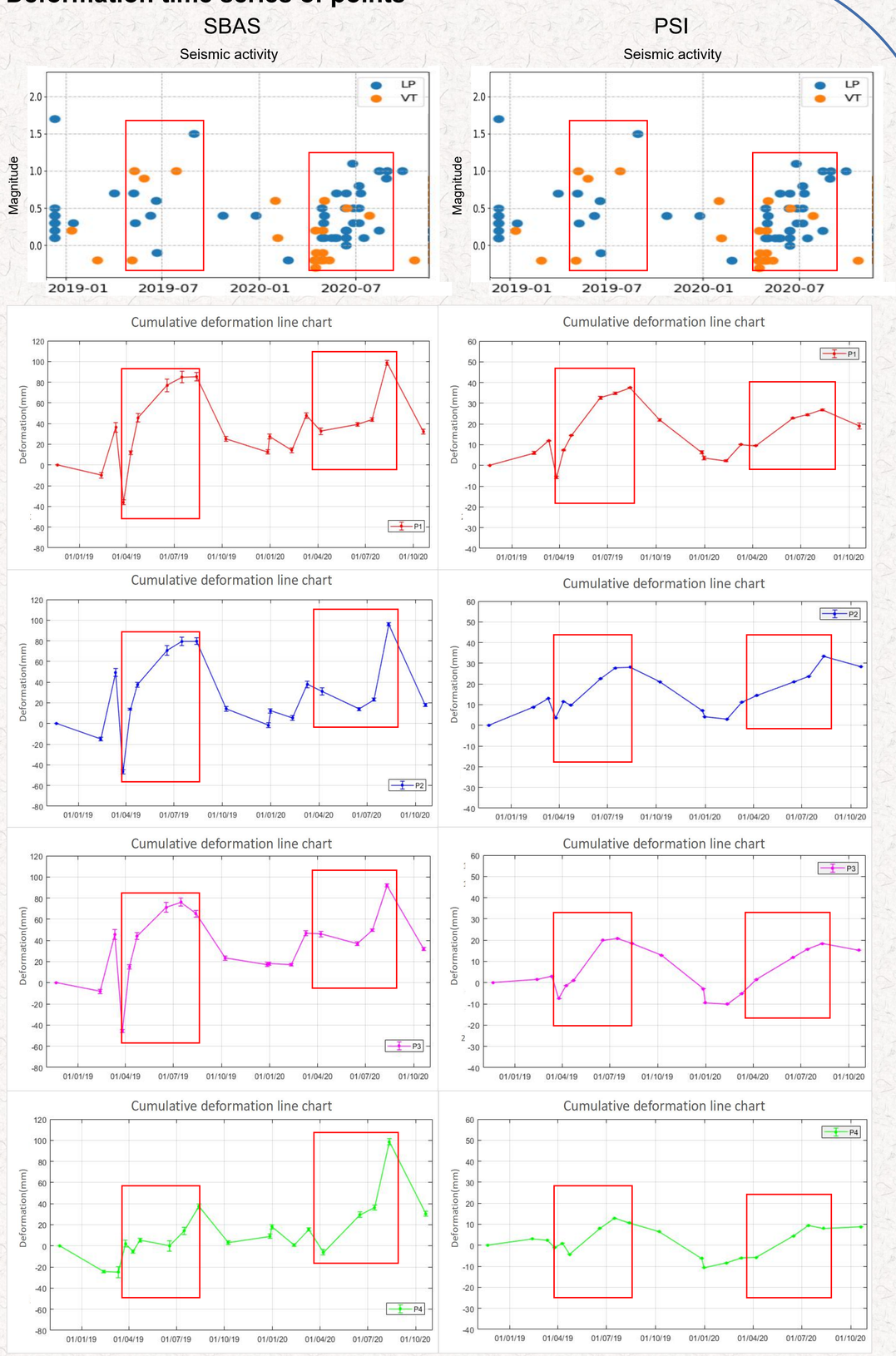


Four points around the crater are selected to analyze the deformation trend. It can be seen that the deformation is increasing from April to September in 2019 and from April to September in 2020. Compared with the volcanic seismicity map, the frequency of volcanic earthquakes is also increasing in the same period.

Mogi modeling

	lon	lat	deep(m)	△V(m³)
SBAS	128.119	41.996	4275	$3.0*10^6$
PSI	128.131	41.987	5554	$3.75*10^6$

Deformation time series of points



Conclusions

- Using SBAS approach, we are able to extract the deformation time series at Changbaishan Tianchi volcano, even though it is covered by thick vegetation.
- From November 2018 to October 2020, Changbaishan Tianchi volcano presents an upward trend.
- Our modeling results show a Mogi point source at a depth of 4-6 km just beneath the crater is responsible for the observed deformation.

References

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