The 2013 Earthquake Series in the Southern Vienna Basin: Location

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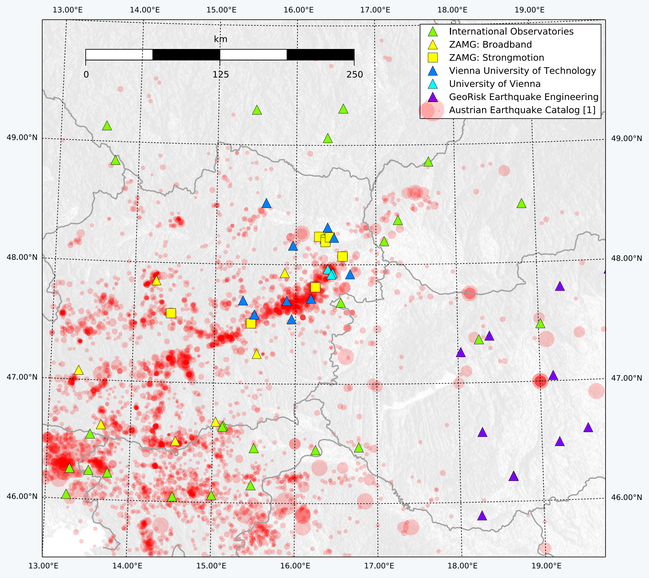
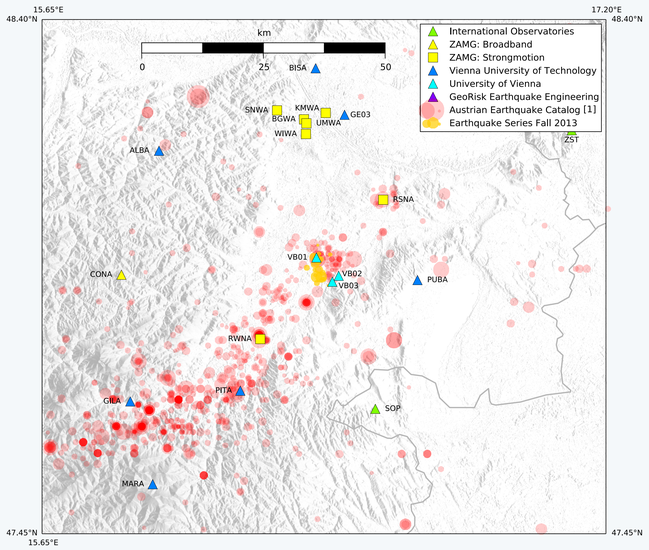
Regional Seismicity

Eastern Austria is a region of low to moderate seismicity [1], and hence the seismological network coverage is relatively sparse. Nevertheless, the area is one of the most densely populated and most developed areas in Austria, in particular Vienna and its surroundings. The largest instrumentally recorded magnitude is around 5, and the Vienna Basin transfer fault occasionally shows earthquakes with magnitudes larger than 4.



Station Networks and Seismic Data

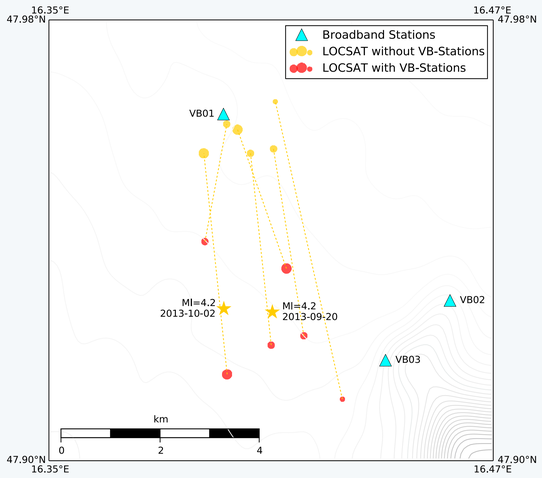


Accurate earthquake locations, including depth estimation and the relation to the faults in the area, is not only important for understanding tectonic processes, but also for estimating seismic hazard. In fall 2013 an earthquake series with 2 main shocks with a local magnitude of 4.2 as well as almost 30 aftershocks occurred around Ebreichsdorf in the Southern Vienna Basin. With portable broadband stations, semi-permanent and permanent stations from different Institutions (University of Vienna, Technical University and Central Institute for Meteorology and Geodynamics) it was possible to record the main- and aftershocks with an unusual multitude of close-by seismic stations. For this study stations at distances up to 240 km are combined in a comprehensive dataset and used for the investigation of earthquake location.

Hypocenter Location with LOCSAT and NonLinLoc

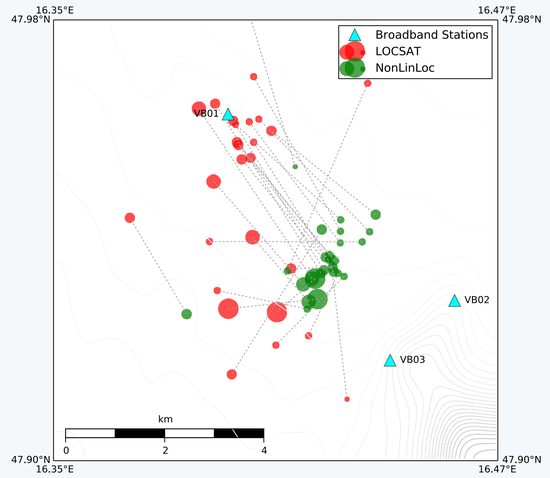
Usually earthquake location and depth estimation in this area is difficult, because the closest seismic station CONA is 40 km away. As part of the ALPAACT Project [2] by the Technical University of Vienna 10 seismic stations were deployed in the Vienna Basin, some of which are used for standard location with LOCSAT and the ISAPEI91 1D-model by the Central Institute for Meteorology and Geodynamics. The University of Vienna deployed three additional stations close to the epicenter of the aftershocks. The following figures show which improvements can be achieved by using more data, different crust velocity models, as well as a different method.

LOCSAT with additional Stations



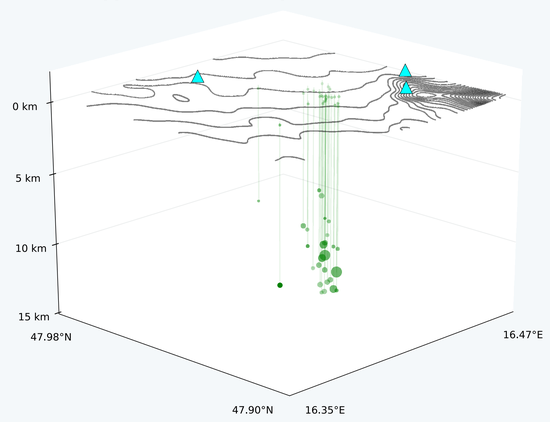
The first step was to add the three close-by deployed stations VB01, VB02 and VB03 to the standard location process. As can be expected a higher station density around the epicenter improves the location. The mean depth of the hypocenters was 11 km.

Location with NonLinLoc and 3D-Modell



To further improve the location we assembled a comprehensive dataset with all available data and repicked the arrivals to unify it. With the program NonLinLoc [3] it is possible to use the 3D-velocity-model [4] [5] After a first location, station corrections were calculated and entered into the final location.

Hypocenters and Spatial Distribution

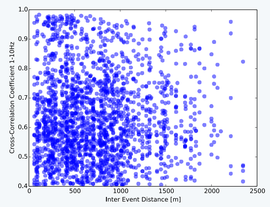


The final locations map most of the earthquake series in an area of 1 x 2 km. The mean hypocentral depth is around 9 km, which is typical in this region as described e.g. in [6]. This means that the hypocenters are beneath the principal displacement zone of the negative flower structure which is assumed for this area [7]. Furthermore the epicenters show a south-west to north-east patterns which maps them to the Vienna Basin Fault System.

With NonLinLoc, 3D-model and station corrections it is possible to get stable epicenters even for sparse station configurations. Although the events can be allocated to a nearby fault,neither pattern of the main shocks and their aftershocks can not be seen with the methods applied and the data used.

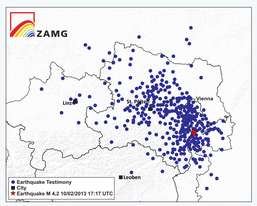
Further Research and Open Questions

Relocation with HypoDD



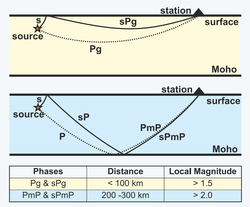
The figure above depicts the crosscorrelation of traces between events. It also illustrates that probably all earthquakes in this series happened in a limited area. HypoDD [8] includes correlation times in the relocation process. Therefore it might be possible to see a rupture pattern if existing.

Directivity Effects



Isoseismic maps from earthquakes in this area [9] as well as earthquake testimonies e.g. the one above, show an asymmetric pattern of intensity. In literature geological causes and radiation pattern of the fault mechanism are used to account for this. With this dataset another aspect will be investigated which could explain this: the directivity of the rupture, as used in [10].

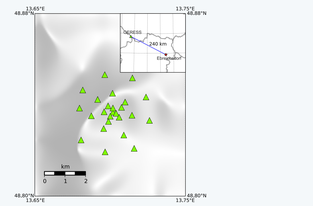
Focal Depth with Regional Depth Phases



Phases	Distance	Local Magnitude
Pg & sPg	< 100 km	> 1.5
PmP & sPmP	200 -300 km	> 2.0

Regional depth phases like shown in the above figure, adapted from [11], can be used to calculate the hypocentral depth accurately even with only one available pair of phases. Especially in sedimentary surroundings depth phase identification can be almost impossible. With this dataset it could be possible to identify such phases and test different methods for improved identification.

Phase Identifcation with Array Processing



Around 240 km from Ebreichsdorf the seismic array GERESS recorded the earthquakes in Ebreichsdorf. In this distance the regional depth phases PmP and sPmP should be well developed. As array processing is a way to improve phase identification we will test if those phases are recorded. If so, methods to include this information for hypocentral location will be explored.

Further research will address the above mentioned questions, additional research concerning this earthquake series moment tensors is shown at EGU 2014 on Thursday in Session SM2.2/NH4.9/TS5.6 on the posters B514 and B518: "DC moment tensor estimation based on P- and S-waveform stacking" and "Seismometer deployment campaign and observations on the tectonics of the Southern Vienna basin fault system"

Acknowledgments

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Location was done with LOCSAT and NonLinLoc [3]. For picking Seismon [13] was used. Plots were created with ObsPy [14].

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