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10 Years of Australian Seismometers in Schools – Education, Outreach and Research

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Abstract

The Australian Seismometers in schools program launched in 2012 with the ambition of bringing Earth sciences to schools around the country and bringing new data to our Earth science researchers. Over the last 10 years we have learnt there is a real thirst for Earth science teaching resources. Most science teachers come from classical biology, chemistry and physics backgrounds and struggle with the Earth sciences components of the curriculum. The introduction of a seismometer into the classroom with support teaching materials has helped teachers and students with the challenge of understanding earthquakes, natural hazards, and tectonics. The data collected by the school seismometers has also provided a valuable resource to our seismology research community. The program provides additional stations to the national network with many stations in less traditional geographic locations such as cities and along the coast. The data quality is surprisingly good quality. Students who can see their data being used by institutions like Geoscience Australia are motivated by their participation in a national science experiment. One thing we have learned is that this program has to be a true partnership. Without the scientist the data loses relevance and without the schools the instruments fall silent.

Keywords: Outreach, Education, Seismic Monitoring, Earthquake Research.

1 Introduction

The AuScope funded Australian Seismometers in Schools program (AuSIS) was designed as a dual-purpose program providing an educational and outreach function for schools and at the same time providing valuable research data to the seismological community.

We launched AuSIS in 2012 after a trial around Canberra in 2011. We chose Guralp 6TD instruments for the program as they provided a 30s-100Hz instrument, functional for both these domains. Less sensitive educational or consumer instruments, such as the citizen science focused Raspberry shakes (e.g. Nepal's Seismology in schools Network (Shubedi et al. 2020)) or the TC-1 (e.g. New Zealand Seismometers in Schools (van Wijk et al. 2017)), are often used for school programs. While most of these instruments have the advantage that their inner workings can be observed and simply explained to students, their research use is limited by their low sensitivity and often limited bandwidth. They also sometimes lack documented instrument responses. In our case we chose a more sensitive instrument not only for research purposes but to ensure that in the seismically quiet intraplate setting of Australia students would be able to see regional and distant earthquakes.

Now, 10 years on, the AuSIS program manages 50 seismometers across Australia (Figure 1.) and feeds near real time seismic data to students, researchers, and monitoring agents. The

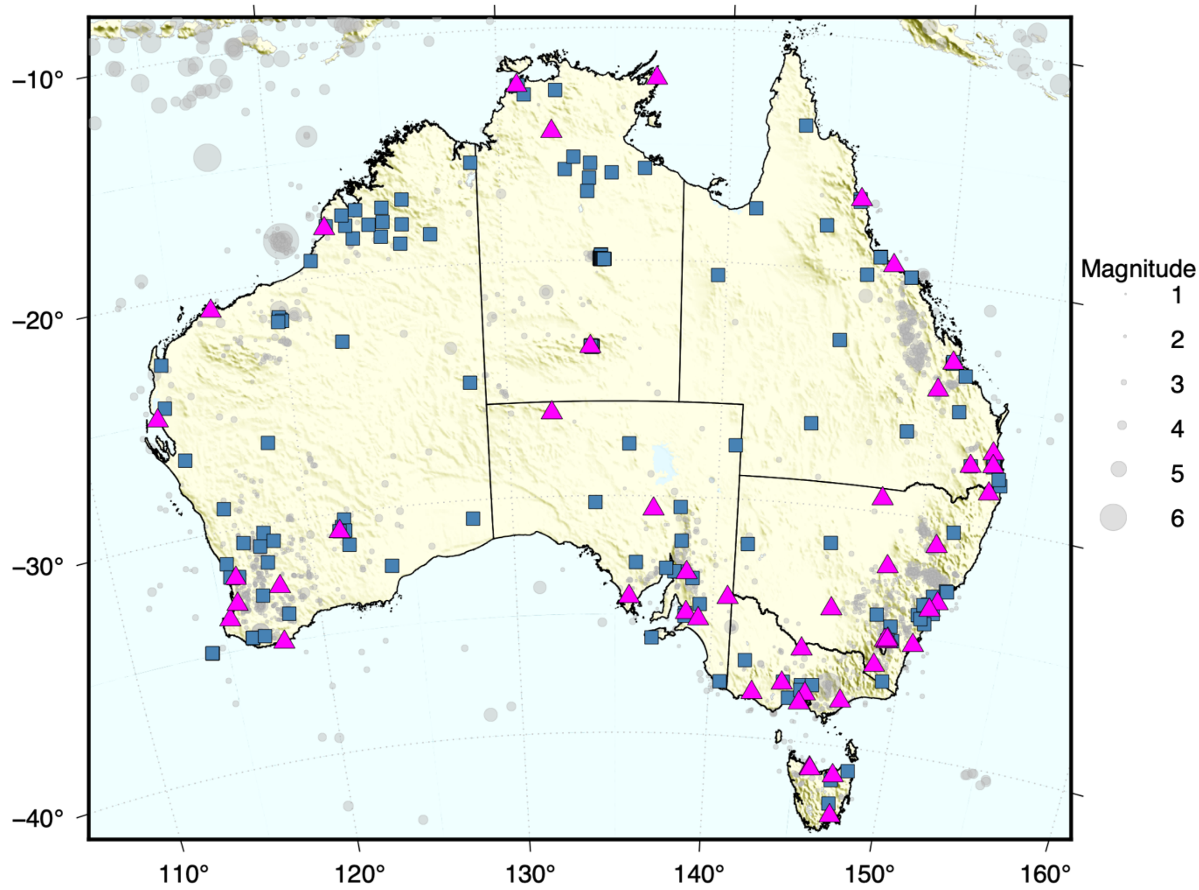

Figure 1. Map of AuSIS (magenta triangles) and Australian National Network stations (blue squares). Grey circles show seismic events where AuSIS stations have been used to help define the earthquake event.

success of the program hinges on the cooperation between the research community and schools.

2 Education/Outreach

The motivation behind the education and outreach component of the AuSIS program was the decline in Earth Science students entering the tertiary education system. Unlike the classical sciences such as Chemistry, Biology and Physics, students entering the tertiary system are often unaware that Earth Sciences is an option for a career. The introduction of Earth Science concepts into the National Curriculum did little to help as many science teachers felt ill equipped to teach Earth Sciences.

The AuSIS seismometers allow students to be part of a national science experiment. At installation we talked to students and made contacts with staff, so we were later able to answer questions and provide support to teachers. A live feed of the data is displayed at the school so they can see the live action from earthquakes around the world. In return the schools help us to maintain the seismometer.

Over the years we have produced teaching modules to help support teachers and we engage with the schools whenever there is a significant seismic event. For example, our schools across the country recorded the 2017 North Korean Nuclear blast (Figure 2.) and we sent images of the recording out to our schools. For significant earthquakes that make the news, or we are contacted about by the school we produce an explainer poster for the school (Figure 3.). We also do school visits on request and student and teacher workshops.

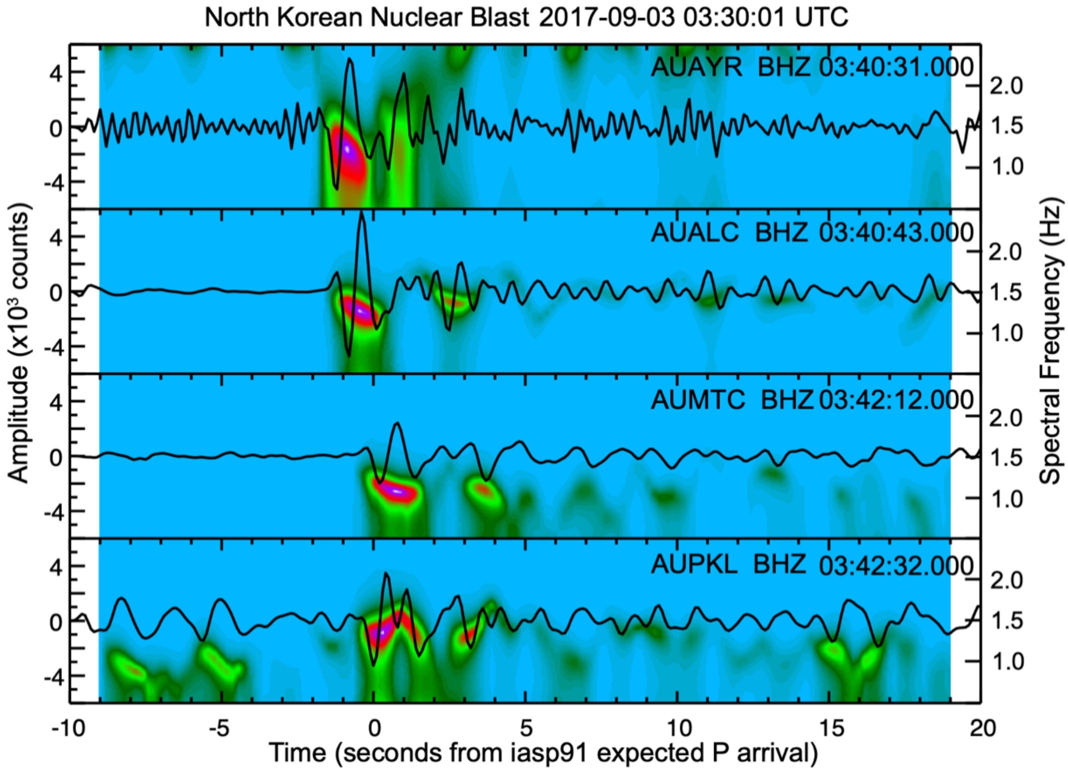

Figure 2. Seismic signals from the 2017 North Korean Nuclear blast. Signals are bandpass filtered at 0.5-2.5Hz. Spectrograms are plotted with each seismic trace. The highest spectral amplitudes (magenta) are observed in the 1-1.5Hz range. These spectral highs highlight the P wave arrivals.

We have expanded out brief to include public outreach with events such as Footyquakes at GIO stadium during National Science Week. A seismometer is installed into the stadium for a game and the crowd's vibrations are recorded as they follow the action on the field.

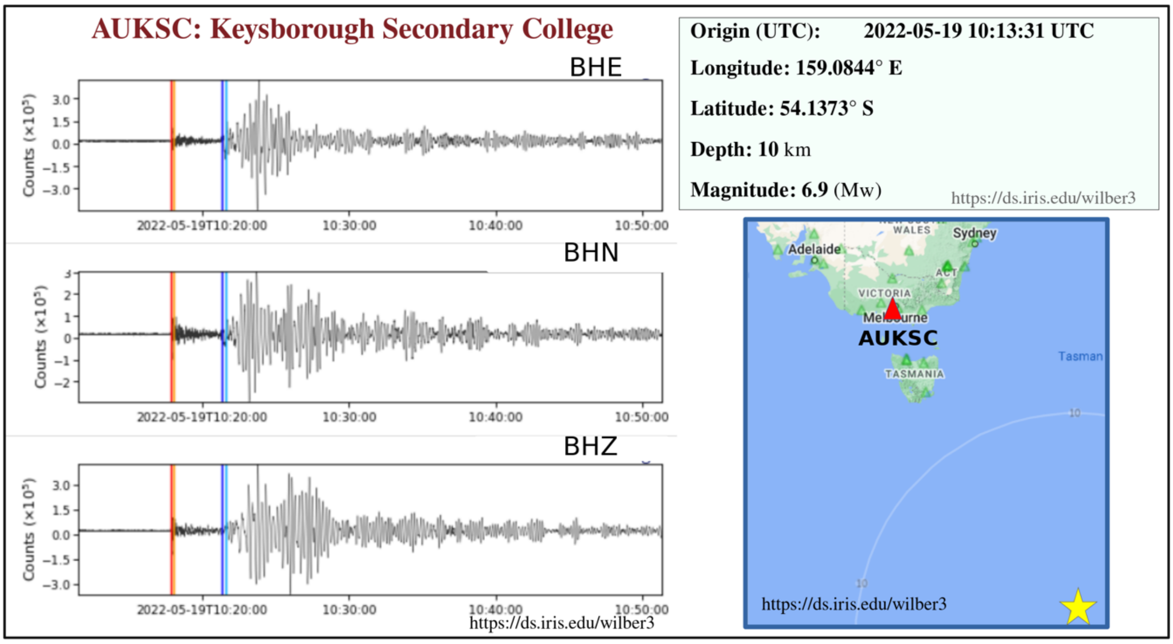

Figure 3. Earthquake poster sent to Keysborough Secondary College.

3 Monitoring

We have provided Geoscience Australia with real time data from our seismometers since 2014 and around 2018 the data was integrated into their monitoring data using a seedlink from AusPass (for details see https://doi.org/10.7914/SN/S1). AuSIS stations have helped to close a few gaps in the national network, particularly around inland NSW as can be seen in Figure 1. The data are now used on a regular basis for locating seismic events. Over the last 4 years AuSIS stations have helped Geoscience Australia locate 6560 events.

The best endorsement we could have came from Geoscience Australia - 'The analysts and duty seismologists are really happy with the extra data for refining solutions, filling in gaps in coverage, and often for smaller events the schools stations are the 3rd station needed to compute a solution at all.' (Personal communications). This has resulted in Geoscience Australia providing us with support fixing issues at sites they are working nearby.

4 Research

The research quality instruments used for AuSIS and the 30s-100Hz bandwidth has allowed these instruments to be used for a wide variety of research including seismic swarms (Murdie et.al 2022), seismic structure (Birkey et al. 2021) and cultural noise (Lecocq et al. 2020). The stations have provided data for at least 4 peer reviewed papers in the last 6 months.

In 2020 AuSIS stations were used as part of a global study looking at the changes in cultural noise due to COVID-19 lockdowns (Lecocq et al. 2020). A global reduction in seismic noise was observed during the pandemic as countries locked down. Figure 4. shows the effect at our Ulladulla High School site on the South Coast of NSW. The software produced for this research also allowed us to better define the long-term cultural noise at our sites. The surprising results show that while our schools are often the hub of the community the noise levels at these sites are often low overnight, during the weekend and during holidays. The example in Figure 4 of Ulladulla High school shows that despite this being a busy coastal town the peaks in cultural noise are limited to weekdays during school hours. This school is fully fenced and there is limited access to the grounds out of school hours. Seismic noise peaks between classes when there are mass movements of students.

We have made the data available to the public through the AusPass data server https://auspass.edu.au/. This data server has a GUI, but also provide data access via FDSN web services and seedlink. Most of the data is also available through Incorporated Research Institutions for Seismology (IRIS https://www.iris.edu/hq/ network code S1) to allow the use of their seismic visualisation tools but this data is incomplete due to their restrictions on data intake.

5 Lessons Learned and Future Outlook

Over the last 10 years we have learnt that partnership and engagement with the schools is the key to keeping instruments running. School teachers are a mobile workforce, in most states they change schools every couple of years. It is best to involve the entire school community in the project not just the teacher that applied for an instrument. Keeping up the engagement and visiting schools allows us to keep contacts up to date and train new school staff. By far the most important staff at the school are the IT staff who keep the live data flowing. Some rural schools have very little IT support and in these cases we have put in our own network infrastructure in the form of 4G modems, so we are able to manage the IT side of it from Canberra.

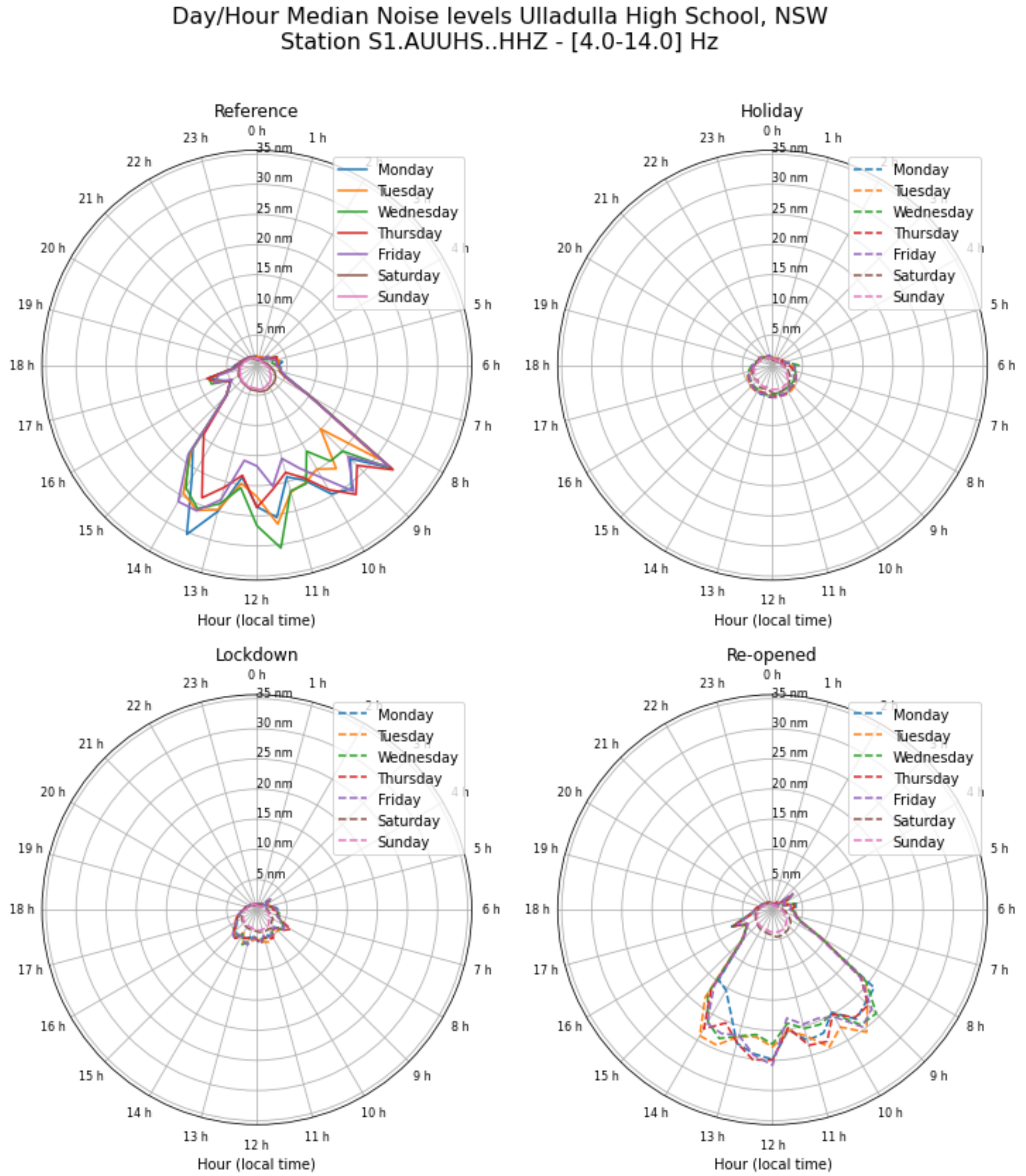

Figure 4. An example of hourly median noise levels calculated for AUUHS at Ulladulla High School using the seismic social-distancing "monitoring" toolkit of Lecocq et al. 2020. The Reference plot (Top left) shows the median noise levels at the site at different times of the day for the period from the beginning of the school term in 2020 (January 27th) to the beginning of restrictions in NSW (March 15th). The Holiday plot (top right) shows the median noise levels at the site at different times of the day for the period from the end of the school year in 2019 (December 21st) to the beginning of the school term in 2020 (January 27th). The Lockdown plot (bottom left) shows the median noise levels at the site at different times of the day for the NSW lockdown (March 25th to May 15th). The Re-opened plot (bottom right) shows the median noise levels at the site as NSW schools reopen (May 25th) to the 3rd of July.

The success of the instrumentation in augmenting the National Network for both monitoring and research has meant the AuSIS program has support from the seismological community. Being able to point to research being done using the AuSIS instruments helps students connect with the science. Research outputs drive our funding so for us to make it to 25 years like the French program (Berenguer 2020) we need users of our data to acknowledge the use.

6 Acknowledgements

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