The Australian Seismometers in Schools Network: a multipurpose network for education, research and monitoring

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Abstract

The Australian Seismometers in Schools Network (AuSIS) is a 4-year program funded by the Education component of AuScope Australian Geophysical Observing System. By 2015 we will build a network of 40 seismometers in high schools across the nation to provide real-time monitoring of the Australian continent and raise awareness of geoscience. This is a multipurpose network that uses professional broadband seismometers to provide research quality data to the seismological community, including monitoring and research agencies. AuSIS is a partnership supported through a volunteer network of scientists, educationalists and enthusiasts in universities, government departments, state surveys and high schools. The AuSIS project's educational aims are to: raise community awareness of earthquakes; raise awareness of seismology and geoscience as a field of study; promote science as a possible career; and provide a tool to assist in teaching physics and earth science.

The program has received significant interest from over 125 schools around Australia and the majority of schools have been selected to host instruments. To date the program has installed more than half the instruments and the data is publically available through the IRIS Data Management Centre. The project also involves an online education portal allowing students to access earthquake recordings in their own and other schools. The data quality has exceeded expectations with some schools recording local earthquakes down to magnitude 1, and large distant earthquakes. Students participate in the program in a multitude of ways depending of their interests and ability. The program is also providing teachers with resources to teach aspects of earth science and physics that are now a compulsory part of the National Science Curriculum.

Keywords: Education, outreach, monitoring

Program Overview

The Australian Seismometers in Schools Network (AuSIS) aims to inspire the next generation of geoscientists by providing students with the opportunity to participate in a national science experiment. The ~40 selected schools get to host a research quality broadband seismometer and view seismic waves recorded at their school from local and distant earthquakes. The AuSIS network is part of the Geophysical Education Observatory established by AuScope. AuScope Limited is a non-profit organisation that manages Commonwealth funded programs aimed to provide research infrastructure to the spatial and earth sciences (http://auscope.org.au/). AuSIS is one of several programs funded by the Commonwealth government's Education Investment Fund (EIF) designed to provide technology to explore the surface and subsurface of the Australian continent. AuSIS has also received additional funding for extra instruments from the NSW government department of Trade and Investment.

The AuSIS program began in 2011 with pilot installations in two schools in the ACT, a control site at the Mt Stromlo seismic vault and an installation at the Research School of Earth Sciences, ANU, designed to assist with trouble shooting. The schools that volunteered for the pilot discovered that their students also benefitted from exposure to real world aspects of physics, geography and social science. Senator Kate Lundy officially launched the AuSIS program in May 2012 at Melrose High School, ACT (Figure 1), after which we invited schools across the country to submit expressions of interest to host a seismometer. The program was over-subscribed by more than a factor of three with over 125 schools wanting to participate. Schools were selected based on their enthusiasm, geographical location and community impact. For earthquake recording at high sensitivity seismologists prefer low-noise environments so the program gave more emphasis to schools in rural and remote communities. This was also in an attempt to distribute the seismometers widely across the Australian continent (Figure 2). Another consideration was that rural schools often miss out on such opportunities and are a focal point of their communities. In each of the main centers we attempted to choose schools that have a track record of sharing their facilities and skills with surrounding schools.

Figure 1. Melrose High School students explaining the recordings from their seismometer to Senator Kate Lundy at the AuSIS launch.

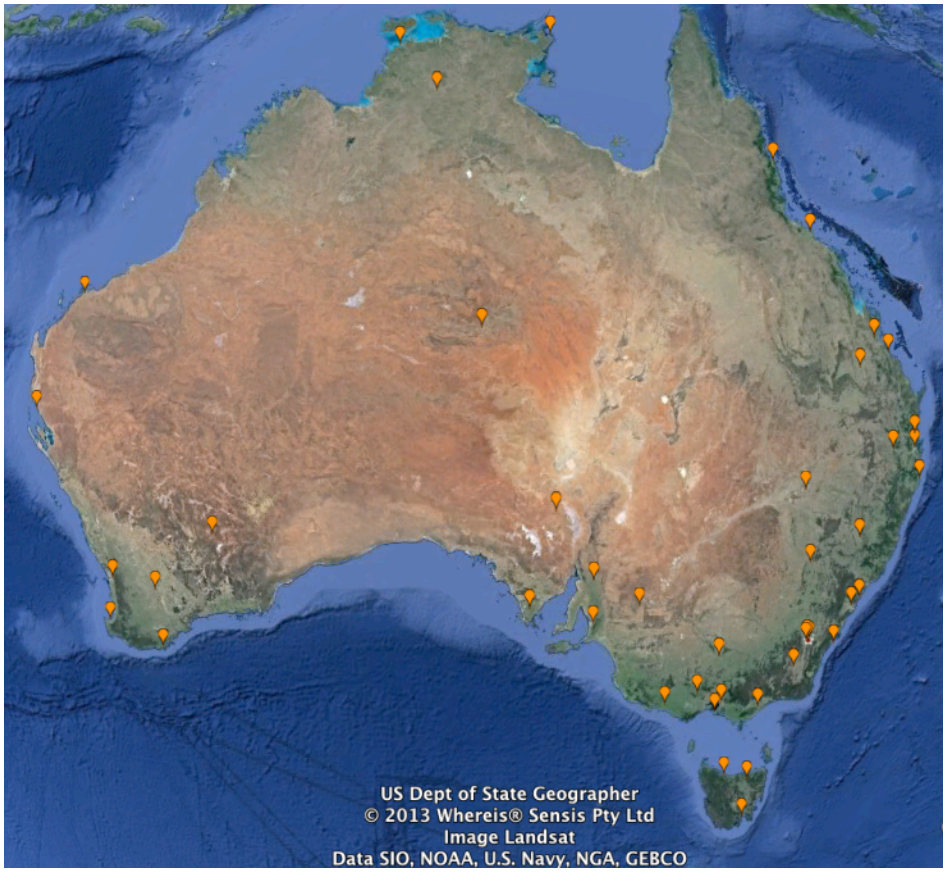

Figure 2. Distribution of schools selected to host broadband seismometers.

In April 2013, we began the nationwide installation starting in Victoria and NSW. With the help of a volunteer network from universities, the government sector and industry, over half of the instruments have already been installed and by the end of 2013 the majority of the instruments will be operational. Some sites occupy areas that are sparsely monitored in an attempt to compliment existing national and regional networks, such as, GA's National Network (http://www.ga.gov.au/earthquakes), The Public Seismic Network (PSN) (http://www.rsuw.daleh.id.au), ES&S regional networks (http://www.esands.com) and DMITRE's South Australian Seismic Network (http://www.pir.sa.gov.au/minerals/earthquakes). There are some schools in Australia that already have seismometers as part of the PSN program and initiatives through DMITRE and UTAS. AuSIS was assisted by these programs in the selection of schools and we hope to share data and educational resources in the future. The continued success of the program hinges on maintaining the engagement of participating schools through partnership with local geoscientists who can provide support for schools, mentorship for students and feedback via a dynamic web site.

Instrumentation and Installation

The primary instruments used are Guralp CMG-6TD and combine a broadband (30 s to 100 Hz) triaxial seismometer and digitizer into a single package (Figure 3). The instruments are networked using Ethernet or WiFi so that data can be streamed continuously from the school to our servers at The Australian National University (ANU) in Canberra. Schools also have a display set up some they can look at the incoming data in real-time.

Figure 3. Installation of Guralp CMG-6TD at Ayr State High School, QLD. The seismic vault was made as part of a project by the schools construction class.

Where possible the seismometers were installed in low traffic areas in the schools. In some cases the seismometer is installed on a concrete pier in the crawlspace beneath a building, however, more commonly they are installed directly on the concrete foundation of the building, where crawlspaces are often not available.

Despite initial doubts that school sites would be too noisy to be useful, we have found local, regional and teleseismic earthquakes well recorded at most schools. For example, in 2011, the school seismometers in Canberra recorded explosions from a factory fire, and in 2012, the M_L 3.7 Wee Jasper earthquake was recorded (Figure 4) providing additional constraints for the location of this event. AuSIS sites clearly recorded the regional M_w 5.4 in South Australia and many large teleseismic events from Indonesia, New Zealand, Japan and Chile. The pilot program demonstrated that although there is some cultural noise during school hours, a well-chosen site within the school has the potential to provide excellent seismic data.

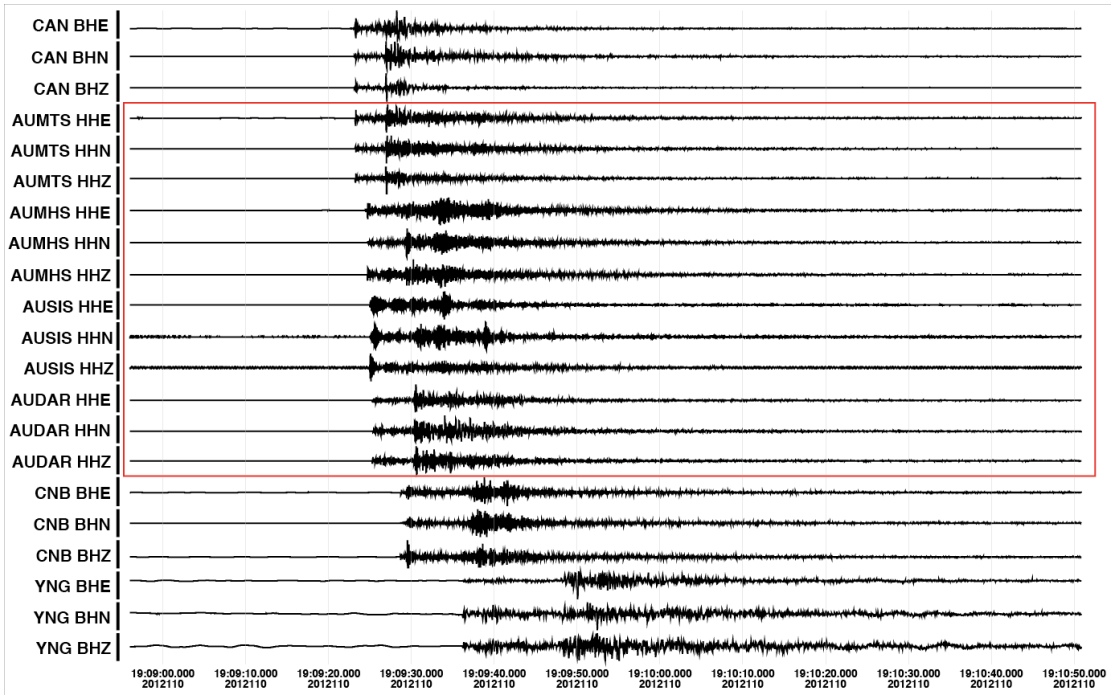

Figure 4. Wee Jasper earthquake recorded with the pilot schools' seismometers (outlined in red) and the national network instruments.

AuSIS aims to keep the schools that missed out on hosting a primary instrument involved by helping them source their own low-cost alternative, such as a slinky seismometer (Figure 5). These single component instruments are less sensitive than the CMG-6TD's and are not calibrated but they are great for showing students how a seismometer works and they can still record local and large distant earthquakes. AuSIS was able to supply 10 schools in NSW with slinky seismometers with additional funding from the NSW department of Trade and Investment.

Figure 5. Slinky Seismometer developed by Boise State University (see http://cgiss.boisestate.edu/bsu-network/)

Data Accessibility

Data collected at the schools is streamed live to ANU where it is sent on to the Incorporated Research Institutions for Seismology Data Management Centre (IRIS DMC) in Seattle, USA, for archiving and near real-time public access. The data is freely available so that researchers, industry and schools alike can all access the data collected. The AuSIS program shares the network code S with international seismometers in schools programs. AuSIS stations can be identified by the first two letters of the site code, which are AU. The IRIS DMC (http://www.iris.edu/hq/) provides services for the community to access the data in some of the following ways: webservices (JWEED, Matlab Library), web-based requests (Wilber3), web service interfaces for online displays, email-based requests (BREQ-FAST), real-time streaming (SeedLink) and metadata only requests (SeismiQuery). Data can also be downloaded in a number of formats from the AuScope Discovery Portal (portal.auscope.org).

Sta Code	Location	Lat	Lon	Elev
AUALB	St Josephs College, Albany, WA	-34.9995	117.9046	0.050
AUAYR	Ayr State High School, QLD	-19.5774	147.4088	0.013
AUBSH	Beerwah State High School, QLD	-26.864	152.9547	0.026
AUBUS	Georgiana Molloy Anglican School, Busselton, WA	-33.6601	115.3828	0.013
AUCAR	St Mary Star of the Sea, Carnarvon, WA	-24.8851	113.6586	0.017
AUCAS	Cummins Area School, SA	-34.2637	135.7219	0.072
AUCSH	Cairns State High School, QLD	-16.9159	145.7682	0.017
AUDAR	Daramalan College, Dickson, ACT	-35.253	149.1377	0.575
AUDCS	Dubbo College Senior Campus, NSW	-32.2334	148.6729	0.279
AUDHS	Darwin High School, NT	-12.44	130.833	0.026
AUHPC	Hawkesdale School, VIC	-38.1068	142.3183	0.011
AUJCS	Jamestown Central School, SA	-33.2047	138.6098	0.464
AUKAL	John Paul College, Kalgoorlie, WA	-30.7637	121.4789	0.373
AUKAR	St Luke's College, Karratha, WA	-20.752	116.8178	0.045
AUKAT	Katherine High School, NT	-14.4624	132.2829	0.122
AUKHS	Kincumber High School, Central Coast, NSW	-33.4642	151.3827	0.027
AUKSC	Keysborough College, VIC	-37.9684	145.1584	0.050
AUKUL	Kulin High School, WA	-32.6697	118.1522	0.312
AULRC	Lightning Ridge Central School, NSW	-29.4262	147.979	0.145
AUMAG	Moama Anglican Grammar School, NSW	-36.1016	144.7482	0.127
AUMAR	Marden College, Adelaide, SA	-34.8916	138.6357	0.035
AUMAZ	Mazenod Senior College, Perth, WA	-32.0069	116.0384	0.263
AUMHS	Melrose High School, Pearce, ACT	-35.3635	149.0888	0.615
AUMOU	Moura State High School, QLD	-24.5752	149.9814	0.153
AUMTC	Earth Ed/Mt Clear College, Ballarat, VIC	-37.6089	143.8771	0.049
AUMTS	Mt Stromlo, ACT	-35.3188	148.9964	0.667
AUMUL	Mullumbimby High School, NSW	-28.5585	153.4949	0.017
AUNHS	Nhulunbuy High School, NT	-12.1874	136.7832	0.020
AUNRC	North Rockhampton State School, QLD	-23.3529	150.5329	0.038
AUPHS	Peel High School, Tamworth, NSW	-31.0989	150.8943	0.408
AURMK	Renmark High School, SA	-34.1728	140.7404	0.026
AUROX	Roxby Downs High School, SA	-30.5601	136.8971	0.106
AURSC	Rosebud College, VIC	-38.368	144.8866	0.023
AUSIS	Jaeger 8, Acton, ACT	-35.2839	149.1147	0.585
AUSMG	Snowy Mountains Grammar, Jindabyne, NSW	-36.4161	148.6084	0.951
AUTOO	Toowoomba State High School, QLD	-27.5452	151.9668	0.687
AUUHS	Ulladulla High School, NSW	-35.3589	150.4696	0.044
AUWSH	Wavell State High School, Brisbane, QLD	-27.3977	153.0372	0.060

Table 1. Station information for AuSIS network. Elevation is in kilometers.

School and Community Engagement

The AuSIS team takes the opportunity when visiting schools to establish a connection between the scientists using the data and the students. We set up a live data feed at the school so that they have the opportunity to monitor and explore the seismic activity recorded. We also give 15-50 minute presentations to up to 6 classes, which include discussions on: the AuSIS program, basic introduction to seismology, what they might see on their seismograph and what seismic data is used for in Australia and around the world. We also take the time to go over the software and technical details with the teachers. Schools do not store more than 24 hours of data onsite unless specifically recorded on a local computer, therefore, we also provide them with guidance on where and how to view historical data online using the IRIS Wilber3 web application and Rapid Earthquake Viewer.

With the introduction of earth science into the National Science Curriculum many teachers are struggling to find resources to help them. As part of the program we have begun to develop teaching modules to assist teachers integrate the seismometer, seismology and earthquake engineering into their classes. So far we have collated existing resources to produce modules on seismic waves, building response, earthquake location and the earthquake cycle. We hope that the teaching modules we provide will help to provide an interactive and relevant way to introduce earth sciences and specifically tectonics and natural hazards to the classroom.

AuSIS has also been engaging with teachers around the country through workshops at Australian Sciences Teachers Association conferences (CONASTA) and National Youth Science Forum (NYSF) (Figure 6). In July 2013, AuSIS combined resources with the Teacher Earth Science Education Program (TESEP), Geoscience Australia (GA) and Geological Society of Australia (GSA) to have a Geoscience Education Exhibition booth at CONASTA to promote geoscience educational resources to teachers.

Figure 6. Teachers at the National Youth Science Forum learning about the properties of seismic waves using a slinky.

Summary and Future Directions

In future we hope to provide professional development courses for teachers to expand their skill base in seismology and earthquake engineering. We aim to have all schools accessing the data recorded by the entire network, connecting students and teachers and scientists around Australia. We are currently beta-testing new software, jAmaSeis, that is developed by IRIS for educational use. Our hope is that it will make data easier for schools to manage and explore, including: allowing students to compare their recordings with those from different networks, be able to measure amplitudes to compute simple magnitudes and locate earthquakes using simple triangulation methods. We are also working on connecting with similar programs run in Australia and other countries so that we can share data and experiences in educational seismology.

The AuSIS website www.ausis.edu.au is still under development but will provide teaching resources and access to data feeds from the seismometers. In the meantime we keep teachers, students and the seismological community informed about recorded seismic events, installations and progress using the AuSIS facebook page www.facebook.com/ausisnetwork.

The goals of the AuSIS program are not only to promote careers in geoscience and raise awareness of earthquake hazards in Australia but also to contribute to the seismological research and monitoring communities. Several schools hosting seismometers as part of the AuSIS network are in areas far from national network sites, such as Nhulunbuy, Moama, Sale, Roxby Downs, Dubbo and Lightning Ridge. The data from these sites have the potential to be useful for local and regional earthquake location. In addition, data collected in urban areas may be useful for seismologists and earthquake engineers interested in site response.

The continued success of this program relies on support from the Australian seismological community, both professional and amateur. We hope to expand our network of volunteers who can provide some support for schools in their area. Another way to support the program is by utilizing the data that schools have been recording and providing feedback to the website developers.