INTERNATIONAL SEISMOLOGICAL CENTRE (ISC)

2016

Annual Director's Report

The year 2016 was a busy productive year for the ISC thanks to the support of 63 Members and 10 Project Sponsors. Bulletin data for earthquakes and other seismic events during recent (2013-2016) and historical (1920-1934) periods were added to the ISC database. The Station Registry, GT-List, ISC-GEM catalogue, the ISC Event Bibliography and CTBTO Link were further extended. The work on the modernized ISC-EHB dataset has begun to benefit researchers involved in seismic tomography. A large number of scientific articles published by researchers in 2016 confirm an extensive worldwide use of the ISC data.

EXECUTIVE SUMMARY

- We gratefully acknowledge generous support received from 63 Member-Institutions in 48 countries and additional project grants (25.5% of the total income) from CTBTO, USGS, FM Global, Lighthill Risk Network, US NSF, OYO, Aspen Re, UK KTP as well as sponsorship from Reftek and GeoSIG.
- Three new Member-Institutions have joined the ISC and three Member-Institutions withdrew during the year. One Member-Institution has been re-assigned as a Sponsor.
- The annual expenditure has exceeded the ISC income by approximately £32,000 whilst essential structural work on the ISC building has been accomplished.
- 17-19 staff members and three consultants worked at the ISC during the year.
- 1,698 stations were registered or modified in the **International Seismograph Registry**.
- Within hours and days after an event occurring, ISC collected and grouped preliminary data from 30 networks and made available as part of **Preliminary ISC Bulletin**.
- The routine process of collection of revised bulletins from 139 institutions stood at 12 months behind real time; a number of agencies were not able to comply with this deadline and inadvertently hindered ISC Bulletin analysis.
- 10 data months were added to the Reviewed **ISC Bulletin** with ~47,000 events and ~5 million arrivals with one further data months in an advanced stage of review. Overall, the entire Bulletin was enlarged by ~357,000 events and ~12 million associated phases.
- The ISC Bulletin is more complete than the bulletins of either the NEIC or the IDC.
- We continued work on the Bulletin **Rebuild** and the **Visual Bulletin Analysis System**.
- We released two further issues of the printed **Summary of the ISC Bulletin**.
- The **ISC-GEM Global Instrumental Earthquake Catalogue** has been extended to include all known earthquakes with M_W 5.5 and above during 1920-1934 and 2013.
- Arrival times, amplitudes and periods as well as body and surface wave magnitudes from the historical part of the ISC-GEM catalogue have been included in the ISC Bulletin.
- The **ISC Event Bibliography** now includes ~ 18,737 articles related to ~15,146 events.
- We continued operating and improving the **CTBTO Link to the ISC database** which experienced a steady stream of data requests from the NDCs and IDC personnel.
- The ISC database and the website mirrors at IRIS DMC in Seattle, ERI in Tokyo and LLNL in Livermore guaranteed improved speed of access to ISC data; another set of mirrors in Beijing and Xian has been built by China Earthquake Administration.
- We continued maintaining and distributing the IASPEI Reference (**GT**) Event List and the List of **International Contacts in Seismology**.
- We started work on the modernised **ISC-EHB** dataset with the first portion of data for 2000-2003 released by the end of the year.
- The ISC staff published several scientific articles and participated in a number of international and regional conferences.
- The ISC has contributed to the work of **IASPEI** by maintaining the IASPEI website, leading several working groups and working at the IASPEI ExecCom.
- The large number of published scientific articles using ISC data indicates wide use of the ISC products by many researchers worldwide.

STAFF and CONSULTANTS

17-19 members of staff and 3 consultants worked at the ISC during 2016, thanks to the regular Member's and sponsor's support and a number of additional grants given to the ISC by international and public institutions and commercial companies to work on the ISC-GEM Catalogue, CTBTO Link and the Visual Bulletin Analysis System (VBAS).

In addition, a member of the Oxford University e-Science Research Centre (OeRC), Mr Saiful Khan, worked at the ISC full time as part of the VBAS project, part-funded by UK Government Knowledge Transfer Programme (KTP). He left Oxford University and joined the ISC in July to continue work on the VBAS.

Among the ISC staff members, there are 8 Ph.D., 5 M.Sc. or equivalent, and 3 B.Sc. or equivalent degrees. The ISC staff represents 11 different countries from 4 continents. Several members of staff took part in professional meetings, travelled to international conferences and participated in professional training programmes.

ISC staff often organise sessions at scientific conferences. Several ISC staff are members of professional organizations such as IASPEI, EGU, AGU and SSA. ISC staff members are engaged in the IASPEI's Executive Committee, commissions and working groups.

MANAGEMENT and ADMINISTRATION

Dmitry Storchak, Ph.D.
Director/Seismologist
Russia/UK

Maureen Aspinwall
Administration Officer,
Retired in September
UK

Lynn Elms
Administration Officer
Joined in August
UK

DATA and SYSTEMS ADMINISTRATION

James Harris
Senior Systems & Database Administrator, *UK*

Przemek Ozgo
Systems and Web Administrator
Left in November
Poland

BULLETIN DATA COLLECTION

The data collection team has an Officer communicating with agencies and doing routine data processing. In addition, there is a seismologist who initiates collection of bulletins from newly established permanent networks, identifies, collects and parses bulletins from past and present temporary seismic deployments and experiments around the globe.

John Eve, B.Sc.
Data Collection Officer
UK

Edith Korger, Ph.D.
Data Collection Seismologist,
Austria

BULLETIN ANALYSIS and BULLETIN REBUILD

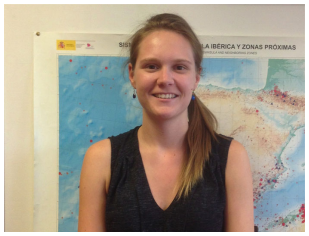
Six analysts are engaged in reviewing of the current ISC Bulletin. Each member of this team has an additional task either in development projects or in data collection. Two further analysts specialise in the Rebuild of the ISC Bulletin for 1964-2010 period.

Rosemary Hulin (Wylie),
M.Phys.Geog., Analyst/
Administrator, *UK*

Blessing Shumba, M.Sc.
Seismologist / Analyst
Zimbabwe

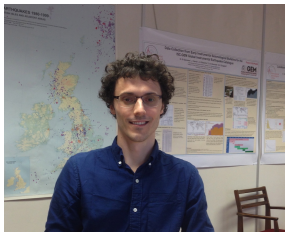
Rebecca Verney, B.Sc.,
Analyst,
UK

Elizabeth Entwistle, Ph.D.
Seismologist / Analyst
UK



Jennifer Weston, Ph.D.
Seismologist / Analyst
UK

Elizabeth Aires (Ball),
B.Sc.Geog.
Analyst / Data Entry
Officer, *UK*



Lonn Brown, M.Sc.
Analyst / Administrator of the Bulletin Rebuild project
Canada

Kathrin Lieser, Ph.D.
Seismologist / Rebuild Analyst, Editor of the Summary
Germany

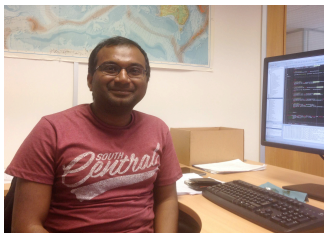
DEVELOPMENT PROJECTS

Domenico Di Giacomo
Ph.D.
Promoted to Senior Seismologist
Italy

Kostas Lentas
Ph.D.
Seismologist/Developer
Greece

Daniela Olaru (Catanescu)
M.Sc.Admin.
Historical Data Entry Officer
Romania

VISUAL BULLETIN ANALYSIS SYSTEM (VBAS) PROJECT



Saiful Khan,
Ph.D. in Computer Science,
Based at the ISC, an employee of Oxford University e-Research Centre during January-June period; left Oxford and joined ISC staff in July
India

CONSULTANTS

During the year, the following persons also contributed to the ISC as consultants either working remotely, at the ISC or both:

- **Emily Delahaye**, M.Sc., *Canada/France/UK*; consulting the VBAS project team, training new analysts, assisting with the ISC Bulletin analysis and rebuild;
- **E.R. Engdahl**, Ph.D., *USA*; taking part in the projects of extending the ISC-GEM Global Instrumental Earthquake Catalogue and ISC-EHB bulletin;
- **Min Chen**, Prof., Ph.D. in Computer Science, *China/UK*; supervising the VBAS project on behalf of OeRC, Oxford University.

OPERATIONS

INTERNATIONAL SEISMOGRAPH STATION REGISTRY (IR) as PART of the ADSL DATABASE

Traditionally, the ISC maintained the International Seismograph Station Registry (IR) together with NEIC/USGS. The IR allocates globally unique codes to seismic stations worldwide.

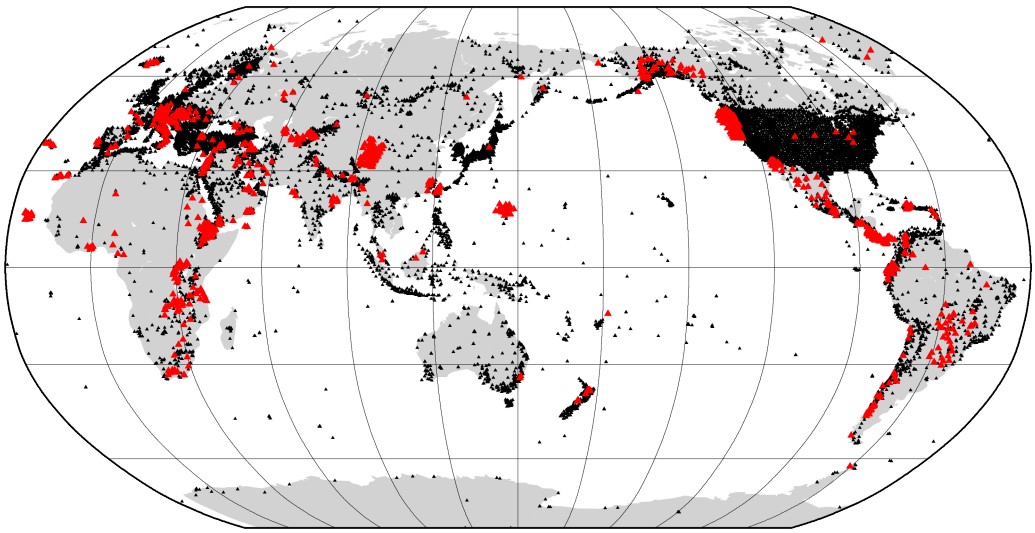


***Figure 1**. 23,759 stations, open or closed, were fully registered in the International Seismographic Station Registry at the end of 2016; parameters of 1,698 of those (in red) were either registered or modified during 2016.*

At the end of 2016, the IR contained information on 23,759 stations. During the same year, the IR has been particularly improved and extended in Europe, the Mediterranean, South-East Asia, East Africa, Central and South America (Fig. 1) as part of the work on:

- including additional or previously missing datasets for the ISC Bulletin Rebuild project;
- updating the IASPEI Reference Event (GT) List and participation in the CTBTO initiative of building the Regional Seismic Travel Times (RSTT).

Stations of the OBS deployment in Cascadia and temporary deployments in Tibet area have also been registered.

The ISC runs a popular web page giving an account of already registered stations as well as inviting the submission of parameters required to register a new station. Figure 2 gives per country account of the IR related web searches.

In fact, the IR has become part of the ADSL database (Agency.Deployment.Station.Location) that we designed and continue maintaining jointly with the NEIC. The ISC maintains the agency.deployment "ISC.IR" as a subset of ADSL. In order to use all waveform data

available on-line, NEIC routinely updates the ADSL database with stations under the deployment codes equal to corresponding FDSN two-character network codes, based on dataless mini-SEED files available at IRIS DMC. The ADSL database is housed at the ISC and the changes are copied to NEIC once a week.

Now and in the future, the globally unique ISC.IR station codes will remain an exclusive source of station position information for the historical period of time. Also, the ISC.IR will continue to cover a large number of stations whose waveform data are not available to the international waveform data centres.

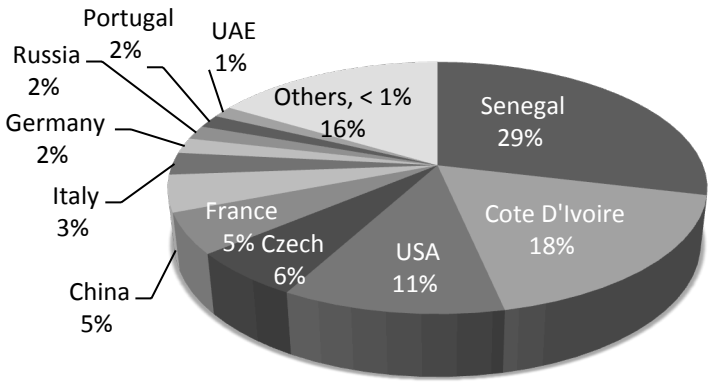


Figure 2. *Per country statistics of the web-searches related to the IR.*

At present, for the majority of its standard operational activities, the ISC uses just the IR (almost equivalent to ISC.IR element of the ADSL database). In order to be able to deal with a multitude of additional stations becoming available for data years 2015-2016, largerly from NEIC, the ISC will need to switch to working with the entire ADSL. To make this happen, a very large effort is required to update, test and validate almost the entire operational and web distribution computer code at the ISC.

COLLECTING PRELIMINARY NETWORK BULLETINS

The ISC continues to collect preliminary bulletin data from a large number of networks and data centres. These data are expected to undergo at least a minimal review by local analysts. Typically the incoming data include a preliminary hypocentre location, magnitude estimates, moment tensor solution and station arrival data, though variations are large from agency to agency. 30 agencies (an increase from 28 in 2015) reported preliminary data to the ISC during year 2016 (Table 1). The two new agencies are INGV in Italy and NCS in India. INGV has restarted its contributions of preliminary solutions. NCS (India) began contributing its preliminary bulletins in addition to the final bulletins that had been reported for many tens of years.

***Table 1**. 30 agencies reported preliminary hypocentre determinations and corresponding arrival time data to the ISC in 2016; new agencies are shown in blue.*

Country	Reporting Agency
Armenia	National Survey of Seismic Protection
Australia	Geoscience Australia
Canada	National Earthquake Hazards Program
China	China Earthquake Administration
Cyprus	Cyprus Geological Survey Department
Czech Republic	Geophysical Institute, Academy of Sciences of the Czech Republic
Denmark	Geological Survey of Denmark and Greenland
Egypt	National Research Institute of Astronomy and Geophysics
France	European Mediterranean Seismological Centre
France	Institut de Physique du Globe de Paris
Georgia	Seismic Monitoring Centre of Georgia
Germany	Helmholtz Centre Potsdam GFZ German Research Centre Geosciences
Germany	Landeserdbebendienst Baden-Wuerttemberg
Hungary	MTA Research Centre, Geodetic and Geophysical Research Institute
India	National Centre for Seismology
Indonesia	Badan Meteorologi dan Geofisika
Israel	Geophysical Institute
Italy	Istituto Nazionale di Geofisica e Vulcanologia
Japan	Japan Meteorological Agency
Kyrgyzstan	Institute of Seismology, Academy of Sciences of Kyrgyz Republic
Norway	NORSAR
Romania	National Institute for Earth Physics
Russia	Geophysical Survey, Russian Academy of Sciences
Russia	Baykal Branch, GSRAS
Russia	Kamchatka Branch, GSRAS
South Africa	Council for Geosciences
Spain	Instituto Geografico Nacional
Syria	National Syrian Seismological Center
UK	British Geological Survey
USA	National Earthquake Information Center, USGS

In addition, there are 17 agencies that switched to a speedy mode of data processing, where bulletins are produced soon after event occurrence and their staff members never return to event re-analysis unless there is a special need (Table 2). These agencies can be considered as reporting both preliminary and final bulletins at the same time.

***Table 2**. Agencies reporting final analysis results within a month of event occurrence.*

Country	Reporting Agency
Albania	Institute of Seismology, Academy of Sciences of Albania
Australia	Gescience Australia
Chinese Taipei	Institute of Earth Sciences, Academia Sinica

French Polynesia	Laboratoire de Geophysique, CEA
Germany	Alfred Wegener Institute for Polar and Marine Research
Germany	Berggiesshubel Observatory, TU Bergakademie, Freiberg
Greece	National Observatory of Athens
Greece	University of Patras, Department of Geology
Ivory Coast	Station Geophysique de Lamto
Kazakhstan	Kazakhstan National Data Centre
Mexico	Centro de Investigación Científica y de Educación Superior de Ensenada
Moldova	Institute of Geophysics and Geology
Poland	Institute of Geophysics, Polish Academy of Sciences
Puerto Rico, USA	Red Sismica de Puerto Rico
Romania	National Institute for Earth Physics
Spain	Real Instituto y Observatorio de la Armada
Switzerland	Swiss Seismological Service

BUILDING PRELIMINARY ISC BULLETIN

Preliminary hypocentre solutions and station arrivals are grouped in the ISC database with corresponding solutions from other agencies and made available through the standard ISC Bulletin search procedure within a few hours of receipt. For each event an output includes several hypocentre solutions reported by various agencies, all reported source mechanisms and magnitude estimates as well as corresponding station arrival data. Earthquake headers include logo images of each reporting agency and, by clicking on the logo, Preliminary ISC Bulletin users can get further information from each agency directly.

Almost all events with magnitude 5 and above and many of smaller magnitudes are reported within the first week. Further reports beyond one week add information to already reported large and moderate events and also inform about smaller events.

This process is there to fill the gap between the event occurrence and the time when the final Reviewed ISC Bulletin becomes available. It presents an attempt to consolidate the effort of many data centres and networks to make their data available internationally in good time. At this stage ISC does not compute or publish its own event solutions. This service is not intended for use by the media or civil protection agencies. It is designed to be used by seismologists to receive as much information as possible in one single format from one single place and then to get access to details using provided links to the original data reporters.

No later than one year after each seismic event occurrence, the preliminary data from agencies are substituted with their final, revised versions; this is well before the ISC analysts make their final review of the ISC Bulletin. The ISC hypocentre solutions are still based only on the revised set of bulletin parametric data given by each reporting institution.

COLLECTING REVISED NETWORK BULLETINS

The standard ISC data collection is the collection of revised bulletin data from many agencies (network data centres and single observatories) around the world up to 12 months behind real

time. With a few exceptions, this delay gives the data contributors enough time for reviewing and finalising their bulletin data before submission to the ISC.

Table 3 lists 139 agencies that contributed revised seismic bulletins to the ISC during the calendar year 2016. It is important to note here that among that number there are at least two regional data concentrators. The East and South Africa Regional Seismological Working Group (ESARSWG, agency code EAF) in fact contributes a coordinated collection of local bulletins from 9 countries: *Ethiopia, Eritrea, Kenya, Malawi, Mozambique, Tanzania, Uganda, Zambia and Zimbabwe*. US National Earthquake Information Center (NEIC) bulletin is also a product based on a multitude of US regional seismic networks. Thus, there were in fact more than 139 agencies that reported to the ISC in 2016.

***Table 3**. 139 agencies reported revised bulletin data to the ISC in 2016.*

Country	Reporting Agency
Albania	The Institute of Seismology, Academy of Sciences of Albania
Algeria	Centre de Recherche en Astronomie, Astrophysique et Geophysique
Argentina	Universidad Nacional de La Plata
Argentina	Instituto Nacional de Prevencion Sismica
Armenia	National Survey of Seismic Protection
Australia	Geoscience Australia
Austria	International Data Centre, CTBTO
Austria	Zentralanstalt fur Meteorologie und Geodynamik (ZAMG)
Azerbaijan	Republic Center of Seismic Survey
Belarus	Centre of Geophysical Monitoring
Belgium	Royal Observatory of Belgium
Bolivia	Observatorio San Calixto
Bosnia-Herzegovina	Republic Hydrometeorological Service, Seismological Obs., Banja Luka
Brazil	Instituto Astronomico e Geofisico
Bulgaria	Geophysical Institute, Bulgarian Academy of Sciences
Canada	Canadian Hazards Information Service, Natural Resources Canada
Chile	Centro Sismologico Nacional, Universidad de Chile
China	China Earthquake Networks Center
Chinese Taipei	Institute of Earth Sciences, Academia Sinica
Chinese Taipei	CWB
Costa Rica	Observatorio Vulcanologico y Sismologico de Costa Rica
Costa Rica	Seccion de Sismologia, Vulcanologia y Exploracion Geofisica
Croatia	Seismological Survey of the Republic of Croatia
Cuba	Servicio Sismologico Nacional Cubano
Cyprus	Cyprus Geological Survey Department
Czech Republic	The Institute of Physics of the Earth (IPEC)
Czech Republic	Geophysical Institute, Academy of Sciences of the Czech Republic
Czech Republic	West Bohemia Seismic Network
Denmark	Geological Survey of Denmark and Greenland
Dominican Republic	Observatorio Sismologico Politecnico Loyola

Egypt	National Research Institute of Astronomy and Geophysics
El Salvador	Servicio Nacional de Estudios Territoriales
Ethiopia	University of Addis Ababa
Finland	Institute of Seismology, University of Helsinki
France	Institut de Physique du Globe de Paris
France	Laboratoire de Detection et de Geophysique/CEA
France	Institut de Physique du Globe
French Polynesia	Laboratoire de Geophysique/CEA
FYR Macedonia	Seismological Observatory Skopje
Georgia	Seismic Monitoring Centre of Georgia
Germany	Alfred Wegener Institute for Polar and Marine Research
Germany	Bundesanstalt und Geowissenschaften und Rohstoffe
Germany	Seismological Observatory Berggieshubel, TU Bergakademie Freiberg
Germany	Geophysikalisches Observatorium Collm
Germany	Helmholtz Centre Potsdam GFZ German Research Centre For Geosciences
Germany	Landeserdbebendienst Baden-Wurttemberg
Greece	National Observatory of Athens
Greece	Department of Geophysics, Aristotle University of Thessaloniki
Greece	University of Patras, Department of Geology
Guatemala	INSIVUMEH
Hong Kong	Hong Kong Observatory
Hungary	Geodetic and Geophysical Research Institute
Iceland	Icelandic Meteorological Office
India	National Geophysical Research Institute
India	National Centre for Seismology, Ministry of Earth Sciences
Indonesia	Badan Meteorologi, Klimatologi dan Geofisika
Iran	Tehran University
Iran	International Institute of Earthquake Engineering and Seismology
Iraq	Iraqi Meteorological and Seismology Organisation
Israel	The Geophysical Institute of Israel
Italy	Dipartimento per lo Studio del Territorio e delle sue Risorse
Italy	MedNet Regional Centroid - Moment Tensors
Italy	Laboratory of Research on Experimental and Computational Seimology
Italy	Istituto Nazionale di Geofisica e Vulcanologia
Italy	Istituto Nazionale di Oceanografia e di Geofisica Sperimentale
Ivory Coast	Station Geophysique de Lamto
Jamaica	Jamaica Seismic Network
Japan	Japan Meteorological Agency
Japan	The Matsushiro Seismological Observatory
Japan	National Research Institute for Earth Science and Disaster Prevention
Japan	National Institute of Polar Research
Jordan	Jordan Seismological Observatory
Kazakhstan	National Nuclear Center
Kazakhstan	Seismological Experimental Methodological Expedition

Kyrgyzstan	Kyrgyz Seismic Network
Kyrgyzstan	Institute of Seismology, Academy of Sciences of Kyrgyz Republic
Lebanon	National Council for Scientific Research
Lithuania	Geological Survey of Lithuania
Macao, China	Macao Meteorological and Geophysical Bureau
Malawi	Geological Survey Department Malawi
Malaysia	Malaysian Meteorological Service
Mexico	Centro de Investigacion Cientifica y de Educacion Superior de Ensenada
Mexico	Instituto de Geofisica de la UNAM
Moldova	Institute of Geophysics and Geology
Montenegro	Seismological Institute of Montenegro
Morocco	Centre National de Recherche
Nepal	National Seismological Centre, Nepal
New Zealand	Institute of Geological and Nuclear Sciences
Nicaragua	Instituto Nicaraguense de Estudios Territoriales
Norway	University of Bergen
Norway	Stiftelsen NORSAR
Oman	Sultan Qaboos University
Pakistan	Micro Seismic Studies Programme, PINSTECH
Panama	Universidad de Panama
Philippines	Philippine Institute of Volcanology and Seismology
Philippines	Manila Observatory
Poland	Institute of Geophysics, Polish Academy of Sciences
Portugal	Instituto Geofisico do Infante Dom Luiz
Portugal	Instituto Portugues do Mare da Atmosfera, I.P.
Portugal	Sistema de Vigilancia Sismologica dos Azores
Puerto Rico, U.S.A.	Red Sismica de Puerto Rico
Republic of Crimea	Vernadsky Crimean Federal University
Republic of Korea	Korea Meteorological Administration
Romania	National Institute for Earth Physics
Russia	Altai-Sayan Seismological Centre, GS RAS
Russia	Baykal Regional Seismological Centre, GS RAS
Russia	Institute of Environmental Problems of the North, RAS
Russia	Kamchatka Branch, GS RAS
Russia	Mining Institute of the Ural Branch of the RAS
Russia	Geophysical Survey of Russian Academy of Sciences
Russia	North Eastern Regional Seismological Centre, GS RAS
Russia	Sakhalin Branch, GS RAS
Russia	Yakutiya Regional Seismological Center, GS RAS
Saudi Arabia	Saudi Geological Survey
Serbia	Seismological Survey of Serbia
Slovakia	Geophysical Institute, Slovak Academy of Sciences
Slovenia	Environmental Agency of the Republic of Slovenia
Solomon Islands	Ministry of Mines, Energy and Rural Electrification

South Africa	Council for Geoscience
Spain	Instituto Andaluz de Geofisica
Spain	Instituto Geografico Nacional
Spain	Institut Cartografic i Geologic de Catalunya
Spain	Real Instituto y Observatorio de la Armada
Sweden	University of Uppsala
Switzerland	Swiss Seismological Service (SED)
Syria	National Syrian Seismological Center
Thailand	Thai Meteorological Department
Trinidad and Tobago	The University of the West Indies
Turkey	Disaster and Emergency Management Presidency
Turkey	Kandilli Observatory and Research Institute
U.S.A.	The Global CMT Project
U.S.A.	IRIS Data Management Center
U.S.A.	National Earthquake Information Center
United Arab Emirates	Dubai Seismic Network
United Kingdom	British Geological Survey
Uzbekistan	Institute of Seismology, Academy of Sciences
Venezuela	Fundacion Venezolana de Investigaciones Sismologicas
Zambia	Geological Survey Department
Zimbabwe	Goetz Observatory

The ISC no longer receives seismic bulletins from the European-Mediterranean Seismological Centre (EMSC). All available bulletin contributions from this region arrive to the ISC directly from individual institutions.

Figure 3 shows countries and agencies that contributed revised bulletins to the ISC directly or indirectly (via other agencies) during 2016. There is currently ~22 months gap between the data collection deadline and the Bulletin production start date. The figure reflects the timeliness and completeness of the data collection. The completeness of the ultimate product – the Bulletin – is expected to be much higher and to include data from a number of agencies/countries missing from the figure.

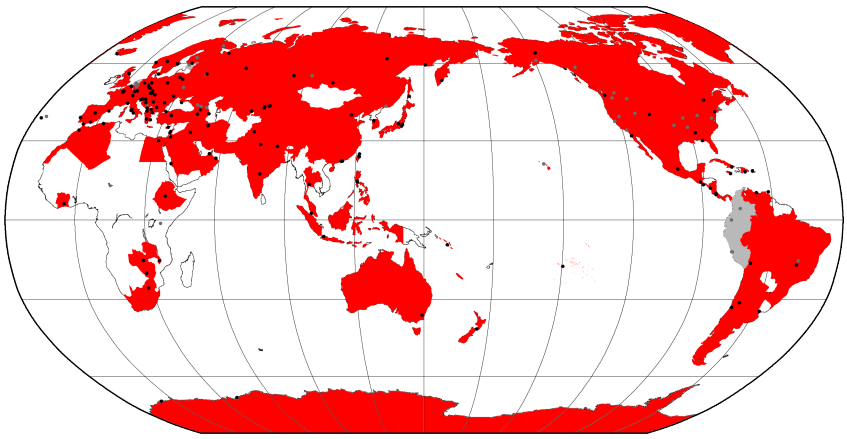


***Figure 3**. Agencies (black dots) and corresponding countries (in colour) that reported revised bulletins in 2016; red/grey colours indicate direct/indirect contributions. Many white gaps will be filled before corresponding data are subjected to analysis.*

ISC BULLETIN REVIEW

The ISC Bulletin is progressively updated with each network report coming in. Preliminary network contributions are substituted with final reviews. New events are built, merged or split with every new report coming to the ISC by e-mail and processed either automatically or manually by the ISC Data Entry Officer, who is working remotely from his home office in Scotland. The Analyst Administrator and the Data Entry Officer regularly review the status of data collection and contact various agencies to avoid reporting gaps.

When the time comes, one month's worth of data is pulled into a separate database and a set of automatic procedures are run to produce the first automatic ISC event locations and magnitude determinations for those events that are large enough to be reviewed by the ISC seismologists. It would be impossible for the ISC to sustain a review of every reported event, so from data year 1999 the data collection thresholds were removed and review thresholds introduced. Following various recent improvements, this system continues to serve its purpose by limiting the number of seismic events to be reviewed by ISC analysts. The threshold criteria are complex yet almost all events of magnitude ~3.5 and larger are reviewed.

The ISC seismologists/analysts review approximately 10-20% of all events formed in the ISC database by the automatic procedures. Although this review misses smaller events, it makes the most used part of the ISC Bulletin accurate and trustworthy. The accuracy of *ak135*-based ISC solutions and magnitude estimates, proper grouping of reported information between the events in the Bulletin is under constant scrutiny. The ISC analysts also review the correctness of automatic association of reported station arrivals to events, reported arrival's phase identification and travel-time residuals.

Throughout 2016, the Analysis Team included six members, each involved in the review process for a certain proportion of their time:

- *Mrs Rosemary Hulin*, Analyst/Administrator;
- *Mr Blessing Shumba*, Seismologist/Analyst;
- *Ms Rebecca Verney*, Analyst;
- *Ms Elizabeth Aires*, Analyst;
- *Dr Jennifer Weston*, Seismologist / Analyst;
- *Dr Elizabeth Entwistle*, Seismologist / Analyst;

The Team was also helped by:

- *Mrs Emily Delahaye*, former Lead Analyst, contractor, coordinating the VBAS project, training new staff and contributing to the Bulletin analysis where possible;
- *Dr Dmitry Storchak*, the Seismologist/Director, engaged in the monthly procedure of identifying previously unreported events based on the un-associated station arrivals.

In addition to the standard Bulletin Analysis, six main members of the team were involved in the VBAS de-bugging and testing (2 person days per week (2dpw)) as well as performing

other tasks such as the Rebuild of the ISC Bulletin (4dpw), ISC-EHB (1dpw), Event Bibliography (1dpw), ISC-GEM catalogue (1dpw) and automatic amplitude measurements from waveforms (1dpw). On average, this amounts to 30% of the team's time.

During 2016, the Analysis Team fully reviewed 10 new data months of the ISC Bulletin (April 2013 - January 2014). A fair amount of work was also done for the data month of February 2014. The Analysts were working with a decreasing number of seismic events compared to the average number during the previous 5 years (Fig. 4). Nevertheless the number of associated phases reviewed by analysts is still on the increase as new stations and networks are set up and corresponding data reported to the ISC.

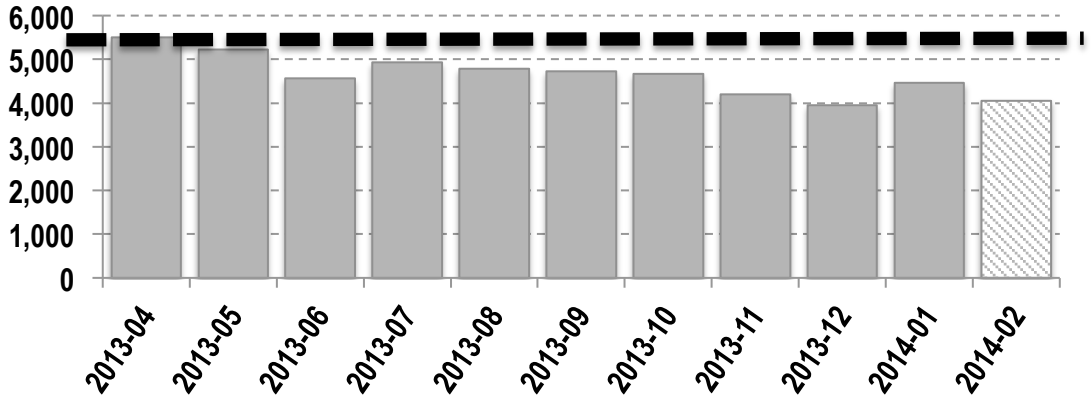


***Figure 4**. Monthly number of seismic events in the Reviewed ISC Bulletin analysed during 2016; the dashed line shows the average monthly number during the preceding 60 months.*

The result of the ISC work can be seen when comparing Figures 5 and 6, showing hypocentre locations reported by all data contributing networks and primary hypocentres in the ISC Bulletin. A fuzzy picture of the worldwide seismicity sharpens up, especially in the case of the Reviewed ISC Bulletin.

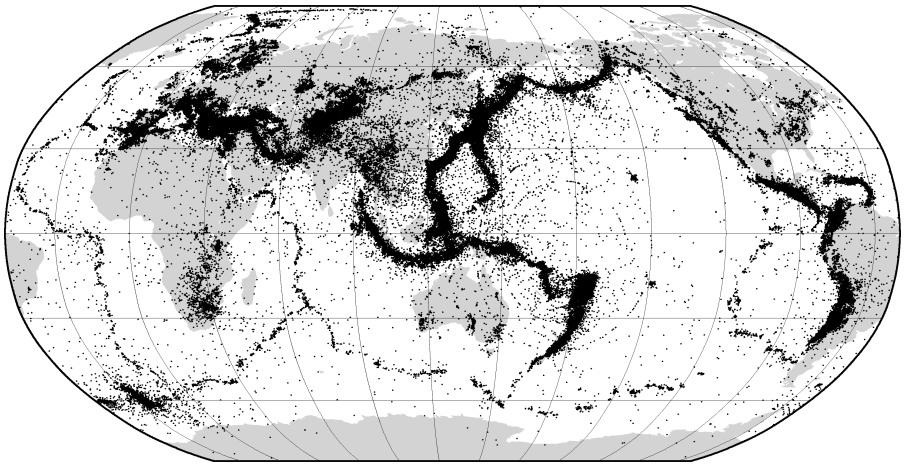


***Figure 5**. All hypocentres reported by individual networks (April 2013 – January 2014).*

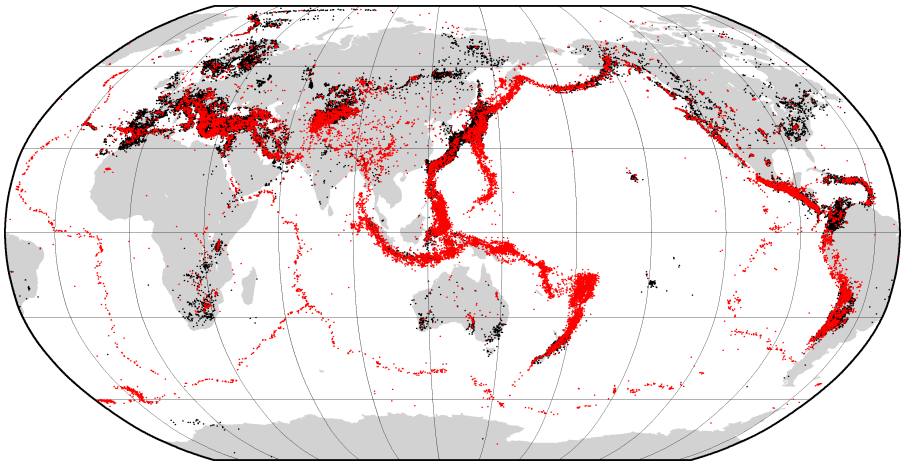


***Figure 6**. Primary hypocentres in the ISC Bulletin (black) in the period (April 2013 – January 2014); red highlights the events reviewed by the ISC analysts.*

During the calendar year 2016, ~47,000 reviewed events with ~5.0 million associated phases were added to the reviewed part of the Bulletin by the ISC analysts. Overall, the Bulletin (both reviewed and un-reviewed) was enlarged with ~357,000 events and ~12 million associated phases. Figure 7 demonstrates the diversity of seismic phases included in the ISC Bulletin.

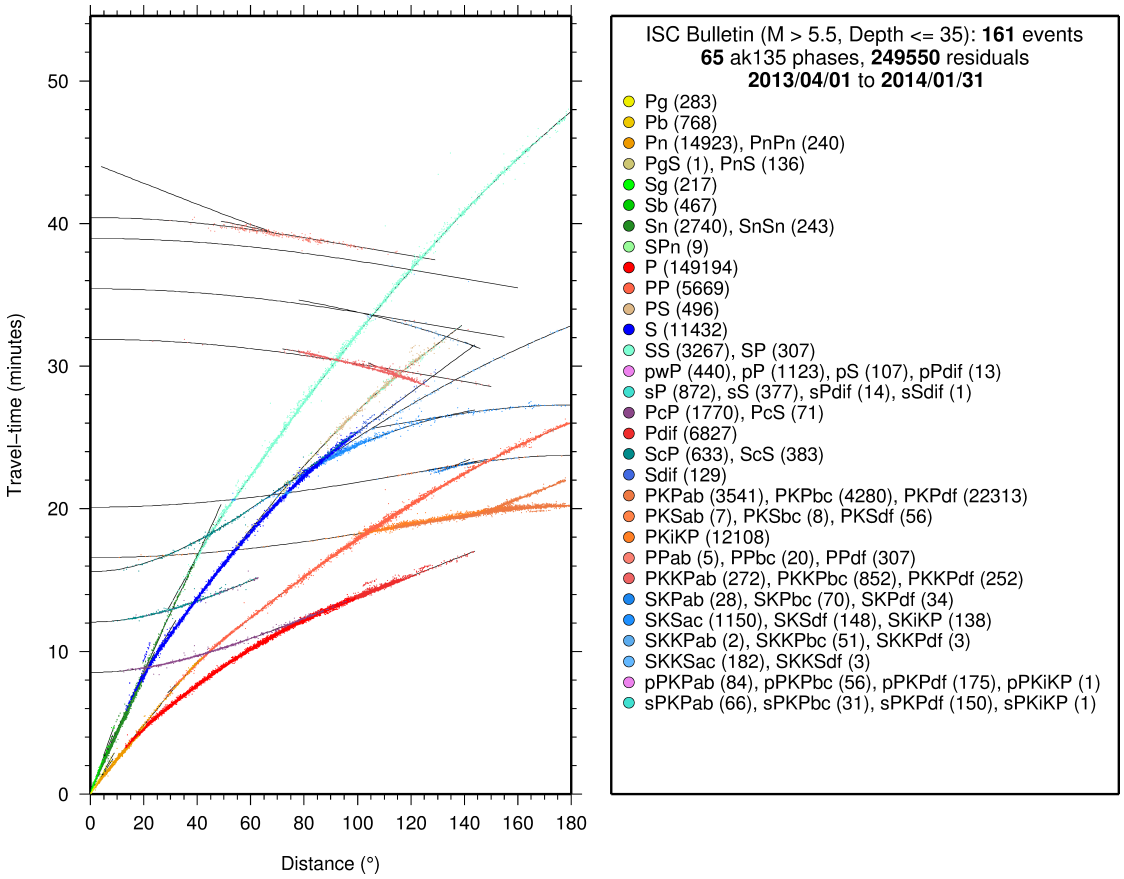


***Figure 7**. The travel-time graph and associated table show the statistics of various seismic phases generated by large shallow events reviewed by the ISC analysts during 2016; 161 events with depth <=35 km and magnitude above 5.5 are shown.*

VISUAL BULLETIN ANALYSIS SYSTEM (VBAS)

With partial support (66.6%) from the UK Government Knowledge Transfer Programme (KTP) and jointly with the Oxford University e-Research Centre (OeRC) we continued work on the development of the Visual Bulletin Analysis System (VBAS) to replace the existing paper-scanner-screen based batch-type analysis. The new system will allow the ISC analysts to concentrate on the review of graphical information summaries with highlighted outliers instead of reviewing all data in text format.

After three years, the KTP support stopped at the end of June (Fig. 8). Although the project has been declared a success, there remained a large number of issues which had to be addressed before the first version of VBAS could become operational.

***Figure 8**. Participants of the last KTP Local Management Committee meeting overseeing the VBAS project at the ISC (left-to-right), front row: Min Chen (OeRC), Maureen Aspinwall (ISC), Gillian Rysiecki (UK KTP) and Dmitry Storchak (ISC); back row: Simon Walton, Hui Fang (OeRC), Emily Delahaye, Saiful Khan, Jen Weston (ISC), Murray Gardner (Oxford University) and James Harris (ISC).*

Following the end of the KTP support, we were fortunate to secure the services of the former KTP Associate (Mr Saiful Khan) and former ISC Lead Analyst (Mrs Emily Delahaye) to work on the project and bring VBAS to an operational state. Saiful Khan has been appointed by the ISC as a Programmer and Emily Delahaye was retained as a consultant.

During the second half of 2016, Emily Delahaye and one of the ISC analysts tested the VBAS software and reported bugs and development suggestions to the VBAS Programmer. The Java Developer and Senior Data Base Administrator have been working on fixing identified bugs, tuning the database queries and updating the software description and manual.

A limited amount of operational analysis work has already been done whilst testing VBAS. With the full introduction and training of the entire Analyst Team sometime during next year, we shall be able to start producing more than 12 data months per calendar year and catching up with real time.

GENERAL STATISTICS of the ISC BULLETIN

The ISC Bulletin and the ISC database grow by the day in both seismic event (earthquake or explosion) numbers (Fig. 9) and reported seismic wave arrival times and amplitudes at stations registered in IR (Fig. 10).

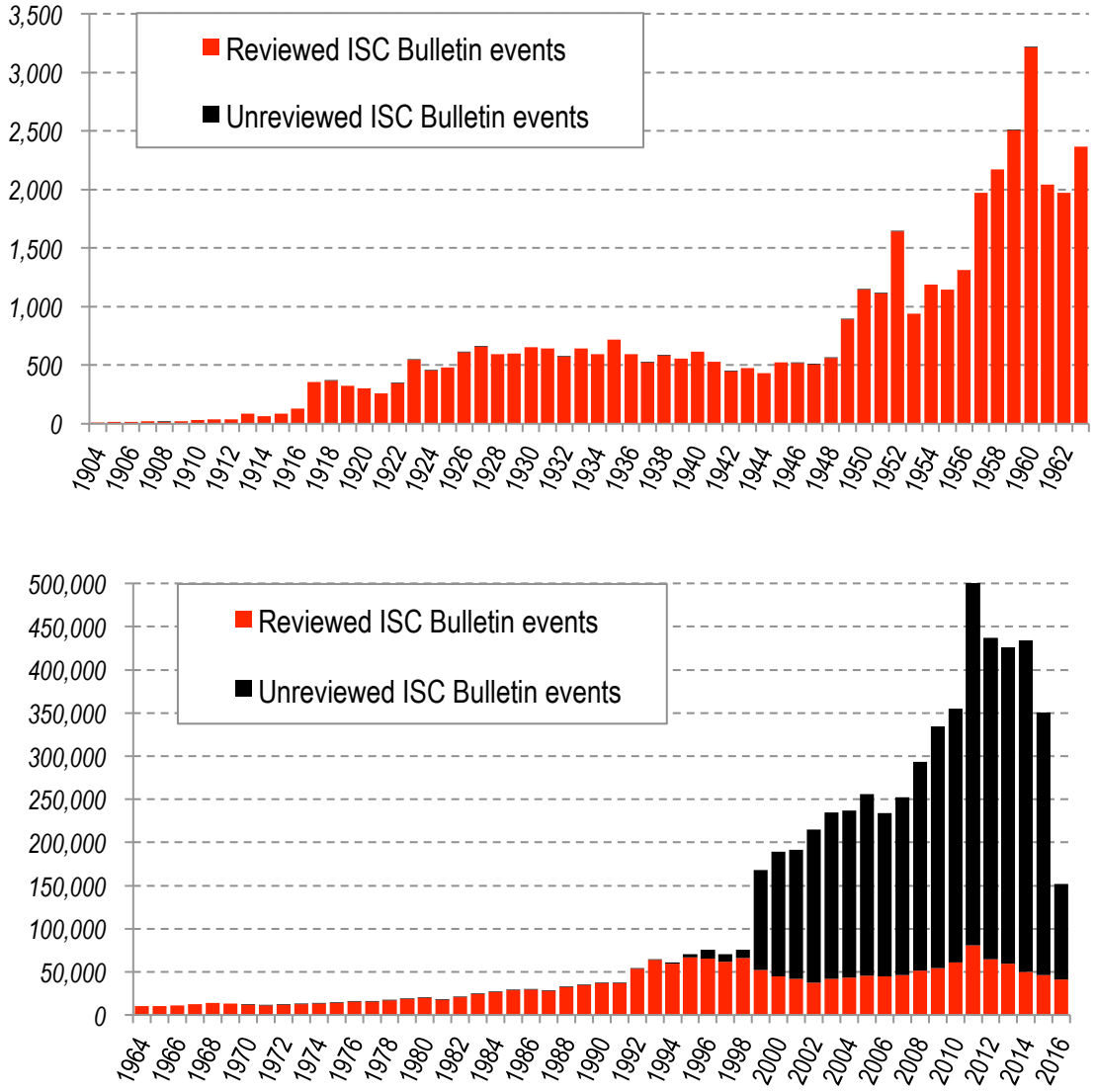


***Figure 9**. Timeline of the annual number of reviewed and un-reviewed (small) events in the ISC Bulletin; the total height of each column represents the annual number of all seismic events in the ISC Bulletin; note different scale used for events before and after 1964; "Reviewed" events in February 2014 - Dec 2016 are those intended for review.*

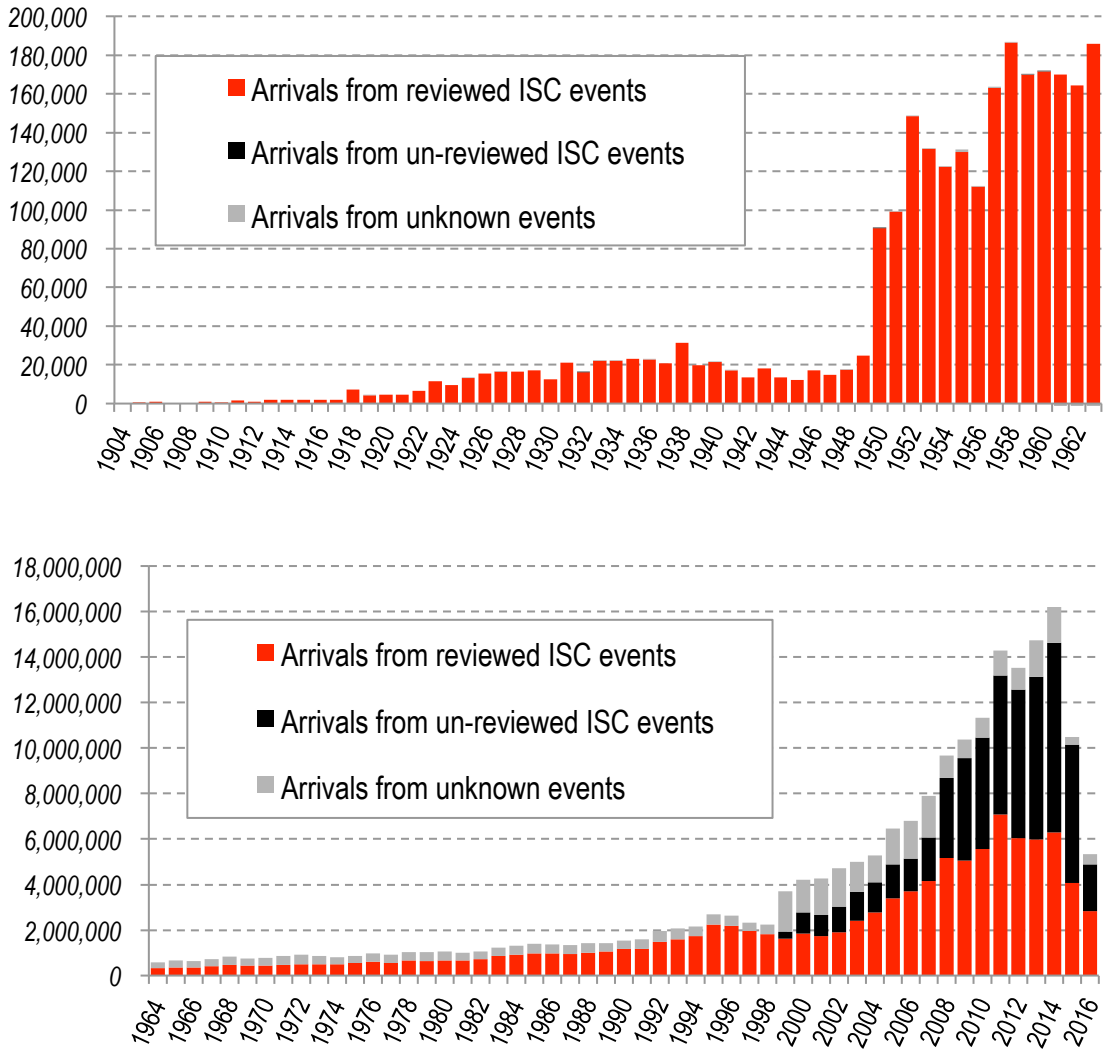


***Figure 10**. Timeline of the annual number of seismic arrivals associated with both reviewed (red) and un-reviewed (black) events in the ISC Bulletin, as well as those arrivals in the ISC database that are not associated to any known events (grey); the total height of each column represents the annual number of all seismic arrivals in the ISC database; note different scales used for events before and after 1964; "Reviewed" events in February 2014 - Dec 2016 are those intended for review*

During 2016, we also made another important advance by parsing the parametric data underlying the most recent (at the time) Ver. 3 of the ISC-GEM catalogue into the ISC Bulletin for the 1904-1970 period. Hypocentre solutions, surface and body wave magnitudes as well as station arrival times, amplitudes and periods have been integrated to the main (and rebuild) bulletin database accounts. Especially important is the inclusion of station arrival times, amplitudes and periods during the 1904-1963 period. In the past, users of the ISC Bulletin had to type these data from the BAAS/ISS bulletin pages. Amplitudes and period readings were not available to the majority of users even in printed version.

Figure 11 demonstrates the comparative magnitude completeness of the ISC Bulletin and bulletins of the NEIC/USGS and IDC/CTBTO. The ISC and IDC Bulletins appear to be more complete globally than NEIC by at least half a unit of magnitude. The NEIC's current global operational magnitude cut-off threshold is 4.5. Smaller events are routinely included only for US territories. Thus, the ISC Bulletin is more complete by definition. The IDC is unlikely to use many more seismic sites/arrays than they use at present because the exact IMS network station positions are written into the Comprehensive Test Ban Treaty. Hence, the Bulletin of the ISC is likely to stay more complete than either of NEIC or IDC.

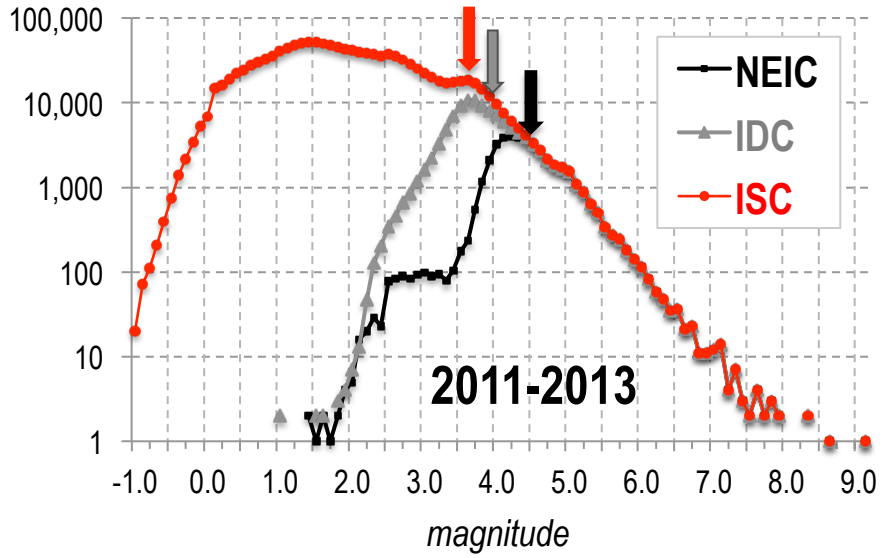


***Figure 11**. Number of seismic events in the ISC, NEIC/USGS and IDC/CTBTO bulletins during the 2011-2013 period; vertical arrows indicate an approximate magnitude of completeness.*

The ISC Bulletin is used by a large number of researchers worldwide. The number of bulletin web searches in 2016 stayed at the level of 2015; it is still in the order of **150 searches per hour** (Fig. 12). The above statistic does not even include searches made through the ISC mirror databases at ERI, CTBTO, LLNL or CEA. Neither does it include individual user searches based on flat bulletin files downloaded by some users from the ftp-site.

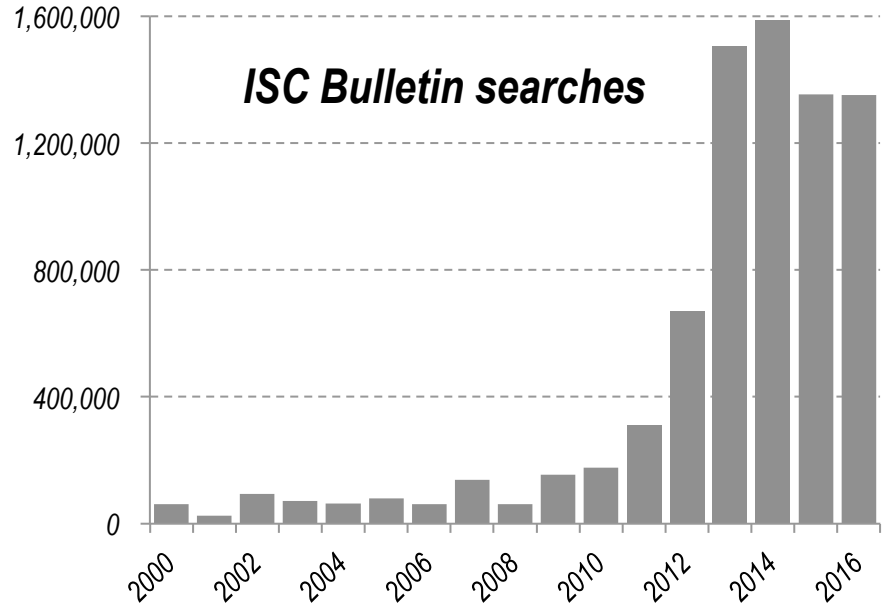


***Figure 12**. The number of ISC Bulletin searches made by website users during 2016 stayed at the same level as during 2015: an impressive **150 per hour**.*

Figure 13 shows the multinational character of the ISC Bulletin search users.

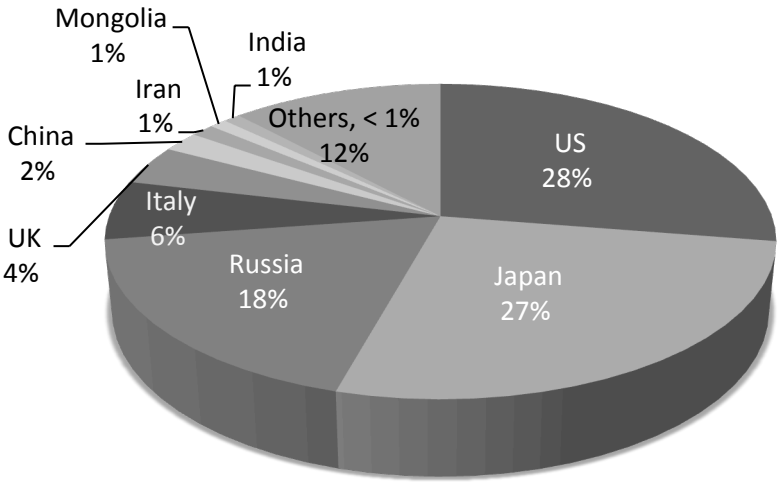


***Figure 13**. Per country distribution of the ISC Bulletin searches made by ISC website users during 2016.*

The above statistics include the use of the ISC mirror website at IRIS DMC, yet it does not include bulletin searches made from mirror-sites at ERI in Tokyo and LLNL in Livermore. Where reliably known, we have removed the numbers related to web crawlers.

Currently, the website searches give output in three major formats: ISF1.0 (International Seismic Format), QML (QuakeML) and CSV (comma separated variables). Figure 14 shows that the total number of searches in QML exceeds those of ISF or CSV. The QuakeML searches, though, are performed by fewer users that tend to run automated queries that take a smaller volume of data. Thus, it is clear that all three formats are popular and need to be maintained in the future.

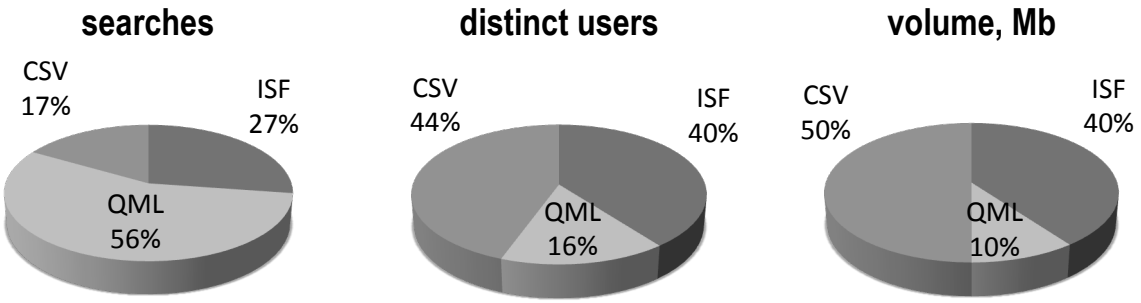


***Figure 14**. Distributions of the number of the ISC Bulletin searches, distinct users and overall volume of data taken per output format.*

PRINTED SUMMARY of the BULLETIN of the ISC

The ISC ceased publication of the printed *Bulletin of the ISC* with the last data of year 2009. From data year 2010 it was decided to replace this publication with the printed *Summary of the Bulletin of the ISC,* which covers six months of the Bulletin data enclosed on a DVD. The old Bulletin was a listing of individual event hypocentres and magnitudes. Two issues of the Summary (Fig. 15) that were produced in 2016 (2013-I & 2013-II) included the following topics:

- The ISC (Mandate, History, Evolution of the Bulletin, Member Institutions, Sponsors, Data Contributors, Staff)
- Operational Procedures (data collection, grouping, association, thresholds, location, magnitude determination, review, history of operational changes)
- Availability of the ISC Bulletin
- Citing the ISC
- IASPEI Standards
- Summary of Seismicity (6 months)
- Invited articles on:
  - Notable Events (*Mw*6.8 **South Kamchatka** and *Mw*8.3 **Okhotsk Sea** earthquakes)
  - Individual seismic network history, status and procedures (**Catalan network**)
- Statistics of Collected Data
- Overview of the ISC Bulletin
- Leading Data Contributors
- Glossary
- Advertisements of the Instrument Producers – Sponsors of the ISC.

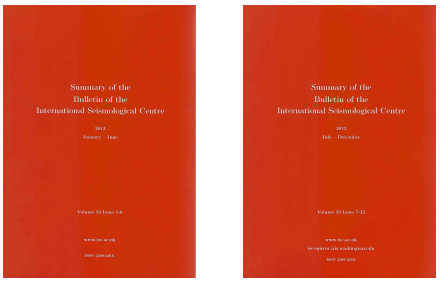


***Figure 15**. Two volumes of printed Summaries of the ISC Bulletin have been published in 2016*

The invited articles from the Summary are also used on the ISC website. Articles on notable events contribute to the ISC Event Bibliography. Network description articles become associated with general information available for each agency contributing to the ISC Bulletin.

As a book publisher, the ISC charges no Value Added Tax (VAT) on its printed products yet VAT on all goods and services that it buys from other suppliers can be reclaimed.

IASPEI GT LIST

The International Seismological Centre maintains the IASPEI database of Reference Events (earthquakes and explosions, including nuclear) for which epicentre information is known with high confidence (to 5km or better, GT5) with seismic signals recorded at regional and/or teleseismic distances (Fig.16a,b). It should be noted that the depth of these events is not known to the same level of accuracy as the epicentre.

The global effort of collecting and validating GT events is coordinated by the CoSOI/IASPEI working group on Reference Events for Improved Location that includes Bob Engdahl, Eric Bergman, István Bondár and Kostas Lentas.

The GT database of 8,969 reference events (1959-2015) and approximately 960,000 station arrival times facilitates better visualization of the Earth structure, better modelling of velocities of seismic waves, more accurate travel time determinations and increased accuracy of event locations.

The ISC users are able to search this database at the ISC website and receive GT locations and corresponding ISC locations along with station arrival data available for each event. A cross-link to the ISC Bulletin is provided for users to go between ISC and GT databases.

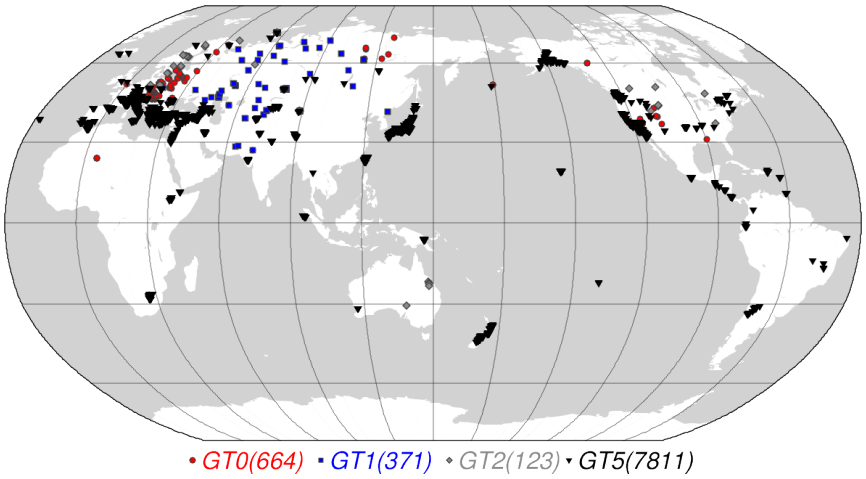


Figure 16a. *The IASPEI List contains seismic events during 1959-2015 for which epicentre information is known with high confidence (to 5km or better (GT5))*

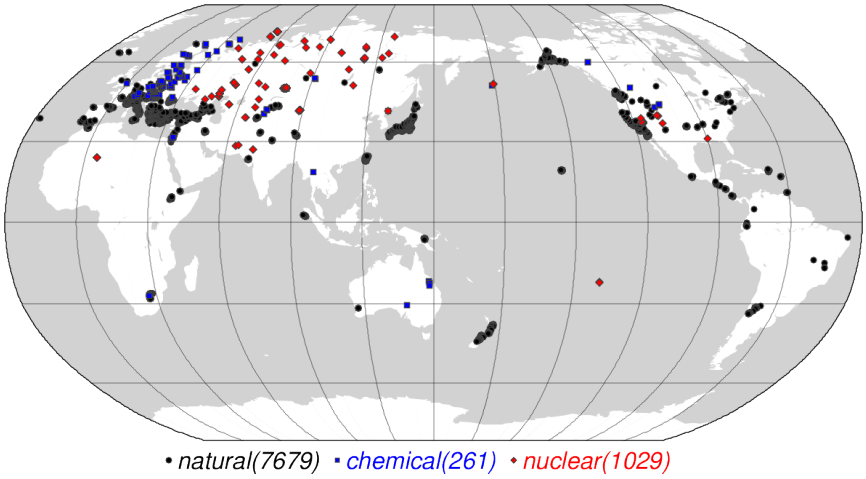


Figure 16b. *The IASPEI List contains natural earthquakes as well as chemical and nuclear explosions.*

At the end of analysis of each ISC Bulletin data year, we add new events to the Reference Event List. During 2016, 297 events have been added or updated (Fig. 17).

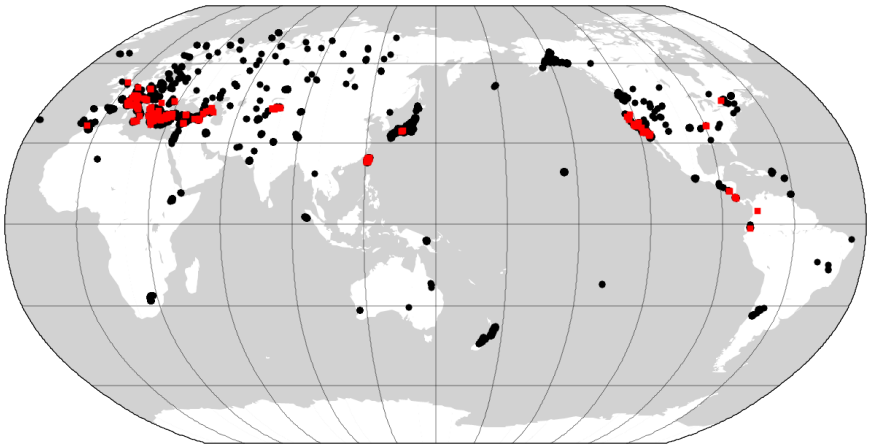


Figure 17. *During 2016, 297 events (red) have been either updated or added to the IASPEI list of Reference earthquakes and explosions*

ISC-EHB BULLETIN

The ISC-EHB Bulletin is a groomed version of the ISC Bulletin, and contains ~136,000 seismic events from 1960 to 2008, where the period 2000-2003 has been rebuilt. Teleseismically well-constrained events are selected from the ISC Bulletin, and are relocated using the ISC (Bondar & Storchak, 2011) and EHB location algorithms (Engdahl *et al*., 1998) to minimise errors in location (particularly depth) due to assumed 3D Earth structure.

The ISC-EHB is a dataset of teleseismically well constrained events. To minimise errors in location due to assumed 3D Earth structure, seismic events are selected based on strict criteria. The EHB algorithm incorporates a specific phase identification algorithm for teleseismic depth phases (pP, pwP, sP, PcP) as well as using PKiKP, PKPdf, PKPbc, PKPab. It is a valuable tool for global and regional seismicity studies and tomographic inversions.

The original EHB stopped in 2008, and since then the volume and quality of data at the ISC has significantly improved. To take this into account we have updated event selection, data

preparation and processing, and relocation procedures. This enabled us to produce a cleaner and more robust dataset.

During 2016, together with E.R. Engdahl of Colorado University, we have applied this approach to events in 2000-2003, and this new dataset has replaced the equivalent years in EHB (Fig. 18). At present, the data years 1960-1999 and 2004-2008 follow the old EHB approach. Over the next few years we shall replace years 1964-1999 and 2004-2014.

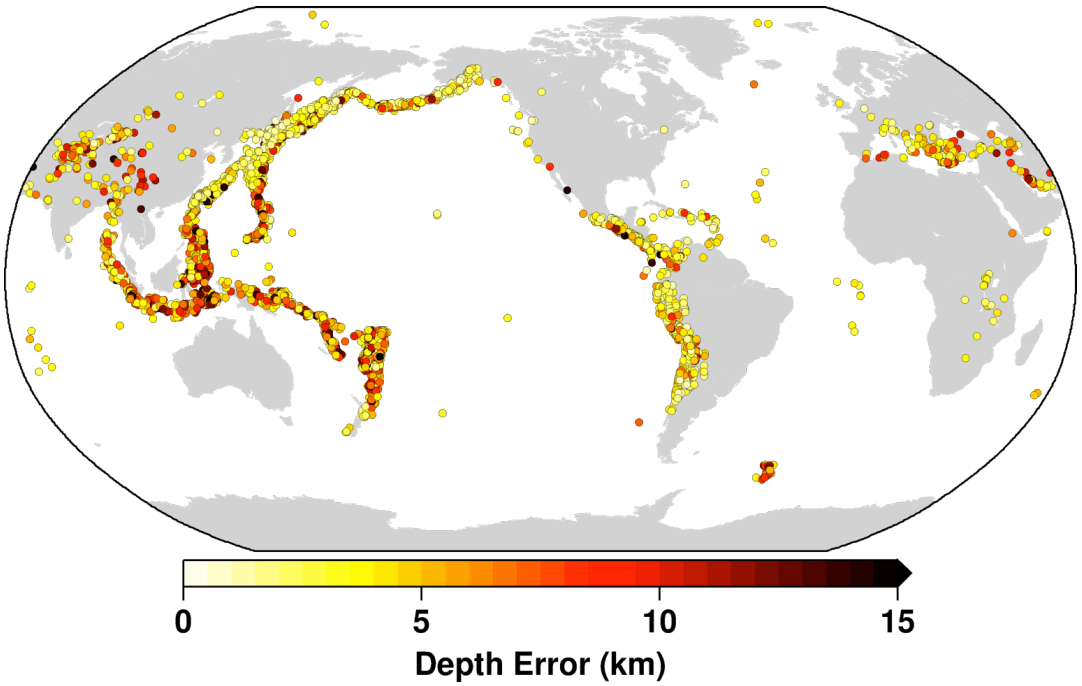


***Figure 18**. The error of depth determination of ISC-EHB events during 2000-2003 period.*

ISC EVENT BIBLIOGRAPHY

The ISC Event Bibliography (first release in April 2013) facilitates an interactive web search for references to scientific publications linked to both natural and anthropogenic events that have occurred in the geographical region of their choice based on earthquake (location, time, magnitude, etc.) and/or publication parameters (author name, journal, year of publication, etc.). The output is presented in a format accepted by major scientific journals. For most recent publications the results include the DOI that allows direct access to scientific articles from corresponding journal websites.

References are collected and linked to events in the ISC database based on the titles and abstracts of scientific publications that could be found in the ISC Bibliography of Seismology, electronic indexes provided by scientific journals as well as references collected during the work on the ISC-GEM Catalogue.

References to publications are not limited to Seismology. They cover a broad range of disciplines including, but not limited to earthquake engineering, tectonics, structural geology, geodesy, remote sensing, nuclear test monitoring, tsunami, landslides, environmental studies, coastal science, natural disasters, hydrology, geochemistry, atmospheric sciences and geomagnetism. This feature makes the Event Bibliography an attractive tool for multidisciplinary studies and useful for researchers and students from different fields.

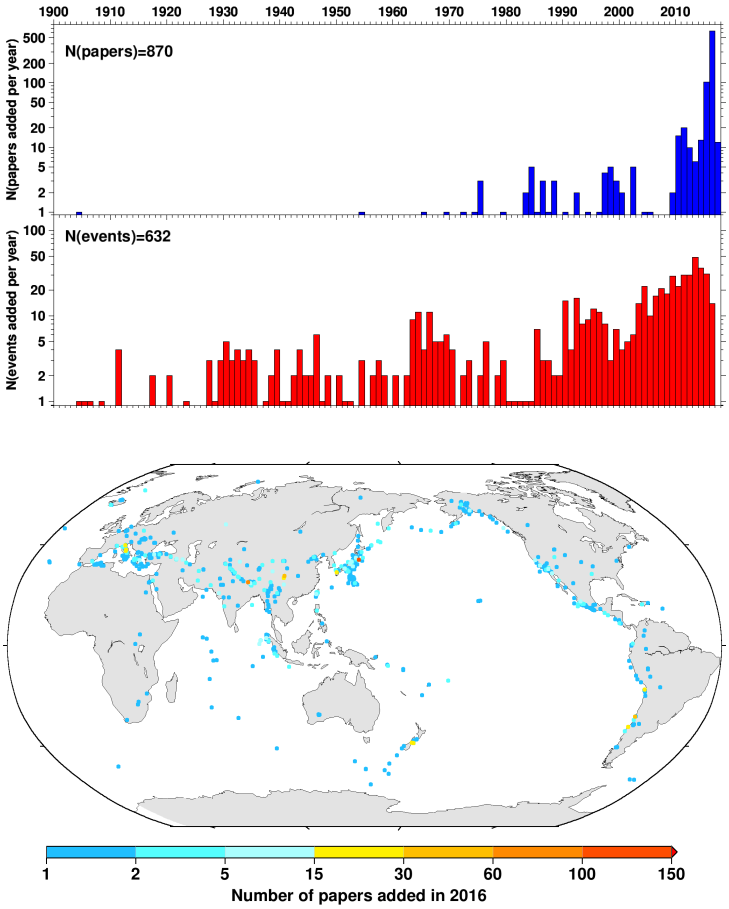


***Figure 19**. Annual numbers and the map of seismic events and related scientific articles added to the ISC Event Bibliography during 2016.*

At the end of 2016, the Event Bibliography included 18,737 articles from ~500 journal titles related to 15,146 seismic events. Seismic events cover the period from 1904 till present; publications covered the period from 1904 till present. Figure 19 illustrates 870 articles related to 632 events that were added to Event Bibliography during 2016.

SEISMOLOGICAL CONTACTS

The objective of this project is to update and maintain up-to-date information on the network of scientific institutions, seismologists and geophysicists in each country willing to serve as scientific points of contact to:

- Seismologists and Geophysicists in other countries;
- Governments;
- Charitable, Response and Relief organizations;
- Media.

Particular care is given to establishing and maintaining contacts in developing countries.

The service benefitted from support in terms of staff time from the Institute of Geophysics and the China Earthquake Networks Center of China Earthquake Administration.

The registry in its current form is readily available for scientific & research institutions, governmental bodies, charitable and relief organizations and media at www.isc.ac.uk/projects/seismocontacts (Fig.20).

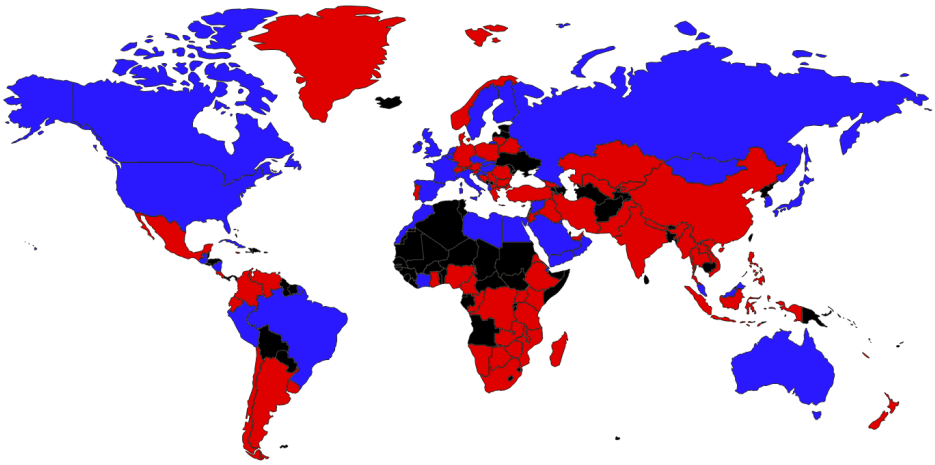


Figure 20. *Seismological Contacts webpage; in **red** are countries in which institutes and individual staff members are willing to share information and serve as a local point of contact; in **blue** are countries for which we have information about operating geophysical organisation(s); in **black** are countries for which we do not hold any information.*

ISC WEB and FTP SITES

In 2016, the ISC website has experienced ~5.3 million hits which is 50% higher than in year 2015. The majority of the ISC web data are distributed through the main ISC website as well as the mirror website at IRIS DMC in Seattle. In the past users could choose the IRIS website to get the most quick and efficient service. In early 2015 we installed the load balancer that automatically directs users queries to the least busy server. It substantially improved ISC user web experience, efficiency and speed of queries. At the same time, due to the new enhanced software now used to track robots, web crawlers and other non-human interaction, we are not able to compare meaningfully the numbers of the ISC website hits in the past and during 2015-2016.

The use of the ISC ftp site has gone up 33% in 2016 compared to 2015. The ftp-site is used for downloading the pdf copies of the printed ISC Bulletins and Summaries, the ISC Bulletin in FFB and ISF formats, the EHB bulletins and the text version of the IR station list.

Per country usage of the ISC web (Fig. 21) and ftp services (Fig. 22) demonstrate worldwide interest to the ISC data.

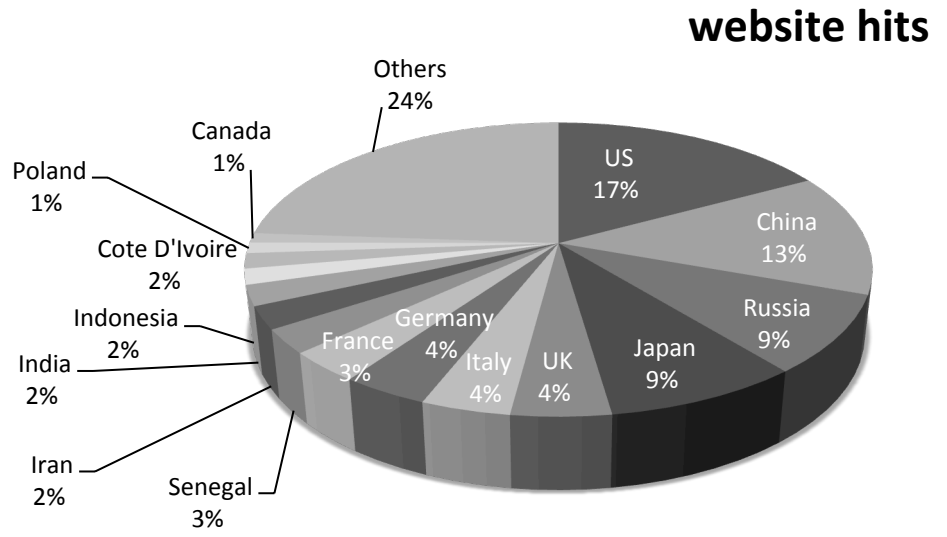


Figure 21. *Per country statistics of the* ***ISC website hits***

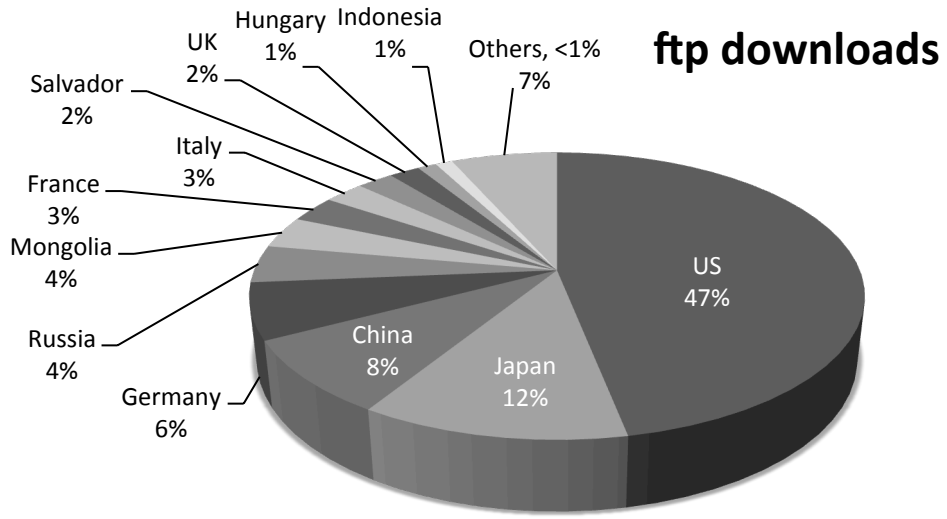


Figure 22*. Per country statistics of* ***downloads from the ISC ftp-site***

ISC DATABASE and WEBSITE BACKUP and MIRRORS

The ISC continued maintaining one of it's servers at the IRIS DMC in Seattle in order to hold a mirror of the ISC database and the ISC website. This was done with assistance from the DMC and US NSF in order to achieve a general ISC data back-up and fall-over facility in case of a breakdown of services at the ISC itself as well as to spread the load on the ISC Internet line and give ISC users faster access to data.

The mirror has been operational since 2011. The database in Seattle is updated with approximately an hour time lag. The Load Balancer evenly distributes the load on the ISC website, including the user searches, between the server at the ISC in Thatcham and the server at DMC in Seattle. Users no longer need to know the exact web address in Seattle and are generally no longer aware which server is addressing their request.

In addition, the IRIS DMC is able to use the database on a daily basis to serve the DMC archive users with event-based selection of waveform data.

Other mirrors of the ISC database are maintained by the Earthquake Research Institution (ERI) of University of Tokyo to serve the research community in Japanese universities and by the Lawrence Livermore National Laboratory (LLNL) to serve users from nuclear test monitoring laboratories in the US.

A new database mirror has been installed in Beijing and Xian by China Earthquake Administration. Once translated, the ISC website will help numerous Mandarin speaking seismologists to obtain more intuitive access to the ISC data. We are currently discussing ways of keeping the main ISC and Chinese mirror website concurrent as possible.

DEVELOPMENT PROJECTS

EXTENSION of the ISC-GEM CATALOGUE

The ISC-GEM Global Instrumental Catalogue was originally requested and funded by the GEM Foundation. It is now widely used for modelling seismic hazard on a regional and global scale. The catalogue is also used as an authoritative reference and a starting point in GEM's regional initiatives in South America, Africa and Asia. The Catalogue has a multidisciplinary use in a wide range of other areas such as studies of global seismicity, tectonics, earthquake hazard forecasting, rapid determination of hazard etc. In addition, the basic observation data digitised by the ISC for use in the catalogue production are now used by individual researchers for historical earthquake studies.

The catalogue is very popular with an average of 11 downloads per day recorded in the last 18 months (Fig. 23). Six scientific publications explaining details of the project were published by the team in a special volume of the Physics of the Earth and Planetary Interior and Seismological Research Letters. References to the ISC-GEM catalogue are becoming progressively more common.

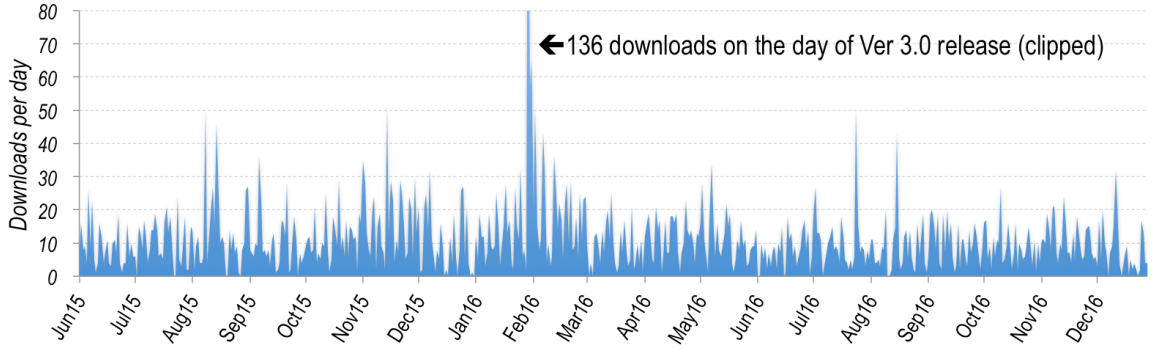


***Figure 23**. During the last 18 months, the ISC-GEM catalogue has, on average, been downloaded 11 times per day.*

The magnitude cut-off thresholds in the original ISC-GEM catalogue were as follows:

- 1900-1917: $M_S \geq 7.5$ worldwide + smaller shallow events in stable continental areas
- 1918-1959: $M_S \geq 6.25$
- 1960-2009: $M_S \geq 5.5$

Since November 2013, we have been working on extending the ISC-GEM catalogue by decreasing the magnitude cut-off thresholds in the early instrumental period before 1960 as well as adding recent years beyond 2009 (Figure 24). This work was supported by the GEM Foundation (during the first two years only), United States Geological Survey (USGS), United States National Science Foundation (NSF), FM Global, Lighthill Risk Network (Aon Benfield, Catlin, Guy Carpenter and Lloyd's) in UK, Aspen Re in Switzerland and OYO Corporation in Japan.

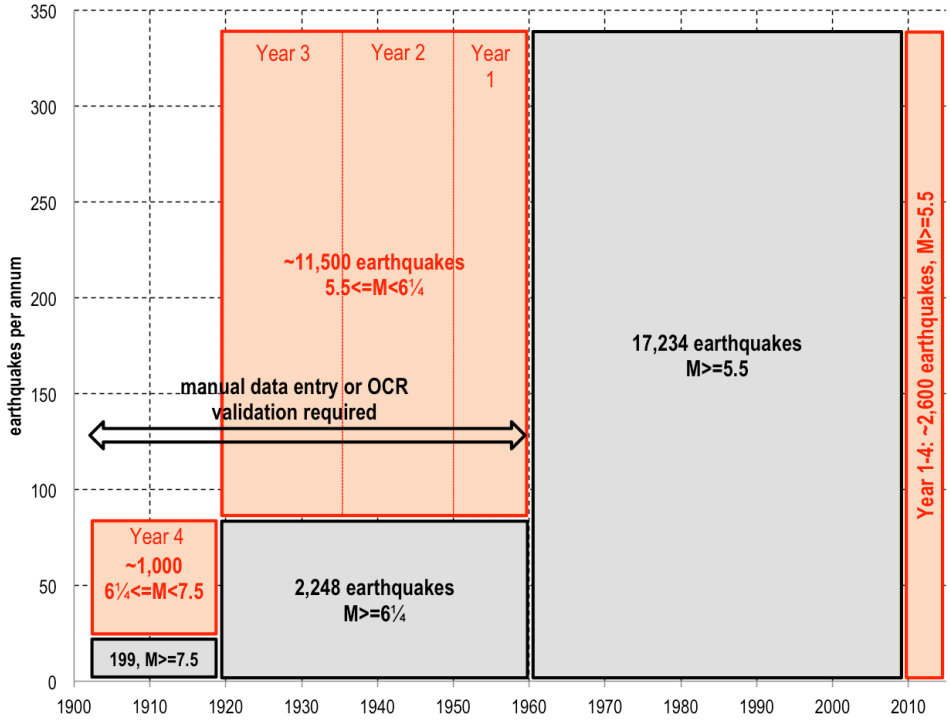


***Figure 24**. Approximate number of earthquakes for each period of time and magnitude interval in the original (grey) and extended (Years 1-3, pink) ISC-GEM catalogue and the approximate number of earthquakes expected to be added to the catalogue during Year 4 of the Extension Project.*

The team that worked on the project during 2016 included several members of the ISC staff and E.R. Engdahl from University of Colorado, Boulder. Several institutions internationally have also helped by providing copies of vital historical data.

Year 3 of the project ended in October 2016 with data years 1920-1934 and 2013 added to the catalogue. We aim to complete the Extension work during 2017 (Fig. 25).

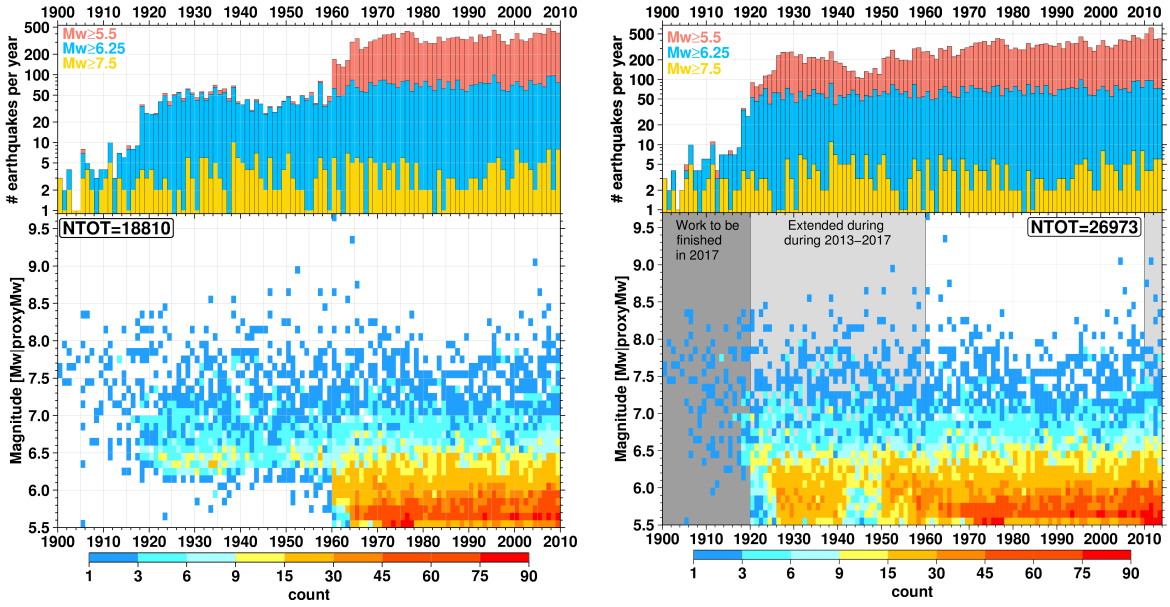


***Figure 25**. Annual number of earthquakes above a certain magnitude level in the main ISC-GEM catalogue in the original version (left) and at the end of the 3rd year of the Extension project (October 2016).*

CTBTO LINK to the ISC DATABASE

Back in 2008, the UK Foreign and Commonwealth Office (FCO) awarded the ISC with a three-year grant to set up a dedicated and secure link to the ISC database for the CTBTO PTS and National Data Centres. The UK FCO provided 90% of the total funding with GEUS (Denmark), NORSAR (Norway), FOI (Sweden) and University of Helsinki (Finland) complementing it with 2.5% each. From April 2011, the funding of the project was taken over by CTBTO. From April 2015, a new annual contract was signed with four possible annual extensions. The contract has now been extended to run until the end of March 2017.

During 2016 we maintained a dedicated server at the ISC that held a mirror version of the ISC database. The dedicated web-based software package designed, maintained and upgraded by the ISC for this service allowed users from the Provisional Technical Secretariat and National Data Centres for CTBTO to query the ISC database in ways specific to the nuclear test monitoring community. The software package includes four types of bulletin searches: area based, REB event based, GT event based and IMS station based search through the wealth of the parametric information in the ISC database.

The objective of the project is to provide the capacity for NDCs to perform various types of analysis such as:

- assessing the historical seismicity in a specific region;
- putting an event of interest into context with the seismicity of the surrounding region;
- examination of observations reported by non-IMS stations;
- comparison of hypocentre solutions provided by various agencies;

- relocating an REB event based on the user selected arrival times available for this event in the ISC database using the ak135 1-D model with optional RSTT regional velocity model;
- investigation of station histories and residual patterns of IMS or IMS surrogate stations.

We also developed an interface for selecting waveforms of non-IMS stations for REB events from the IRIS DMC, EIDA and GeoNet archives. For each recent REB and GT event, this interface:

- allows selection of stations by distance / azimuth to the REB epicentre;
- shows the number of stations, for which waveforms are available at all three archives;
- exhibits pre-prepared images of selected waveforms, filtered and un-filtered with theoretical first arrivals indicated on top of the waveform images;
- offers a form to request part of waveform, based on absolute or relative theoretical arrival times of required seismic phases or on group velocity of surface waves;
- triggers a request to waveform archives; as a result, users receive required waveforms by e-mail in the SEED format.

Figure 26 shows user activity on the Link by both PTS/CTBTO and NDCs.

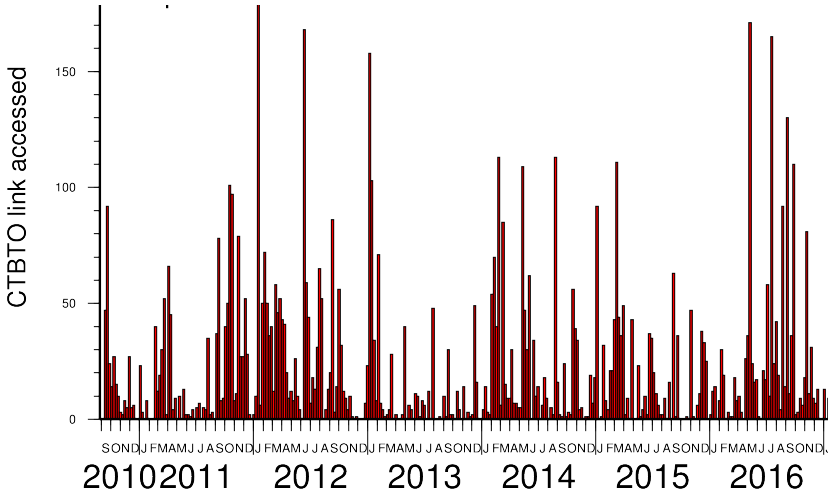


***Figure 26**. The Link to the ISC database mirror is provided to the NDCs through the IDC secure website. The figure shows the healthy stream of user activity.*

This project also benefits the ISC and the ISC users.

- The ISC development staff acquired important skills and experience during this project. The advances made under this project are gradually implemented to improve the traditional open ISC web services.
- In particular, experience of downloading, checking quality and processing waveforms on an industrial scale helps the ISC's efforts towards making its own automatic waveform measurements to further improve the quality of the ISC Bulletin.
- The ISC and its Bulletin users gained a much speedier access to the REB Bulletin which is now usually available in monthly batches within 20-50 days after an event occurrence as opposed to half a year to a year in the past (Fig. 27). Efforts are being made to arrange for even faster REB availability in daily batches.

- Many National Data Centres for CTBTO are run by institutions that are either Members of the ISC or reporters of data to the ISC.
- Several NDC's either became ISC Members or increased their financial contributions, based on the added value of the ISC service.

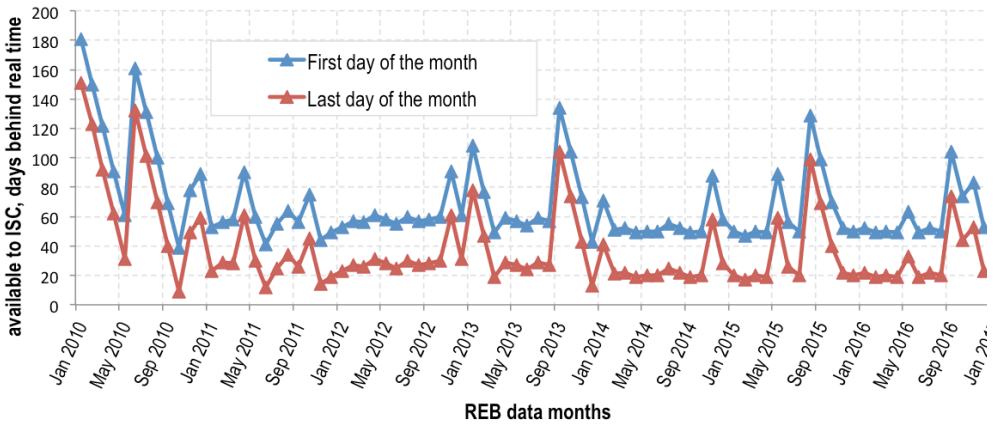


Figure 27*. The availability of the IDC REB data to general ISC Bulletin users (days behind real time) has considerably improved with the routine operation of the CTBTO Link. End-of-year glitches are going to be addressed by CTBTO by setting more automated procedures for providing bulletins to the ISC with certain delay.*

It also has to be noted that although the software created under this project is open only to the monitoring community, the actual data used by them are exactly the same as used by all ISC users: the ISC Bulletin, GT List, EHB and International Seismograph Station Registry.

ISC BULLETIN REBUILD

The value of the ISC Bulletin is dependent upon adhering to uniform procedures over a long period of time. Nevertheless, essential changes in the ISC procedures have occurred:

- The *ak135* velocity model has been used since 2006 superseding the *JB* travel times.
- A new event Locator based on a different approach was introduced from data year 2009.
- Throughout the ISC history different sets of seismic phases were used for location: P & (from 2001) S with other *ak135* phases from 2009.
- Latitude & longitude error estimates were computed before Oct 2002, followed by full error ellipses later on.
- Procedures that determine which reported events require relocation by the ISC were also changed in 1999, 2005 and 2006.

We are currently rebuilding the ISC Bulletin using current ISC procedures to guarantee homogeneity throughout its entire period. As part of this project we are:

- Re-computing all ISC hypocentres with uncertainties (an example on Fig. 28);
- Re-computing all ISC event magnitudes with uncertainties;

- Soliciting, obtaining and integrating essential additional datasets that were not available at the time of the original ISC Bulletin production;
- Performing essential integrity and consistency checks, quality control and correction.

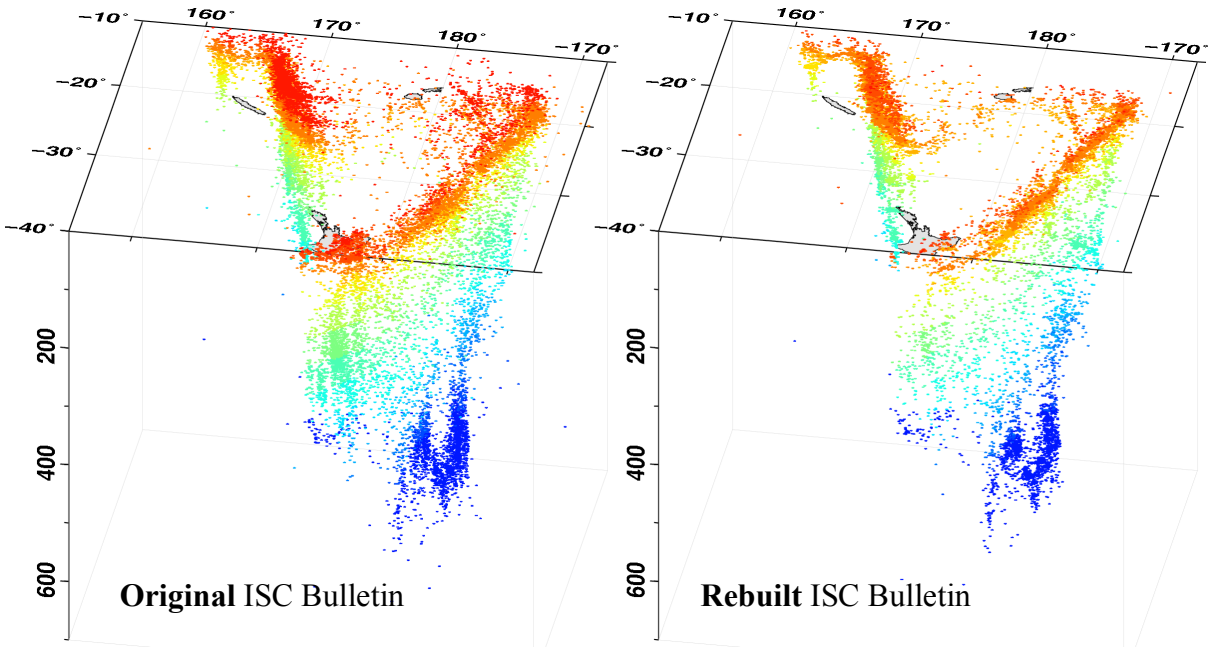


Figure 28. *Seismicity of the Fiji-Tonga-Kermadec area in the original (left) and Rebuilt (right) ISC Bulletin.*

The ISC Rebuild Analyst Team (an equivalent of 2.7 full time analysts) review all events with considerable departures of main hypocentre parameters from the original ISC solutions as well as events with unacceptable travel time residuals at individual stations.

During 2016, we have completed the review of seismic events within the period 1964-1975. The speed of this review was highly variable for different data months, which makes estimates of the likely end of the project highly uncertain. We are trying to speed up the review as much as possible aiming to complete the project whilst we have the analyst resources available. We plan to update the main ISC database with the results from this project as soon as the 1970s have been fully reviewed. Until then, the results of the project are not made available to ISC users.

MAKING OBS WAVEFORM PICKS for the ISC BULLETIN

Currently there is a number of ocean bottom station (OBS) installations operated by research institutions around the world. Waveform data from many of them are freely available. As part of a summer work placement for a student from the Royal School of Mines, Imperial College, London, Luke Cottell, the ISC ran a pilot project to obtain additional parametric data from one of the OBS deployments to better constrain some event locations in the ISC Bulletin.

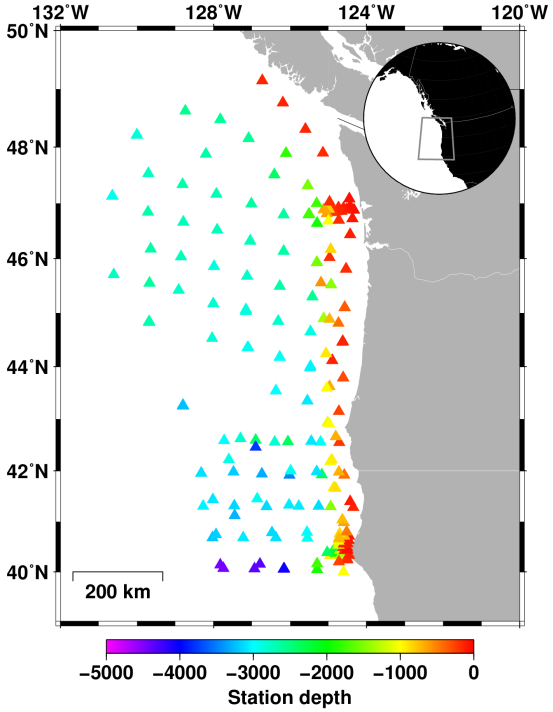


***Figure 29**. Location map of the OBS stations colour-coded by the depth below sea level.*

We reviewed the waveform data from Cascadia Initiative Community Experiment - a new ocean bottom seismograph deployment off the coast of the NW United States (Fig. 29), installed during 2011-2015 at variable depths of 56m-4464m below sea level (IRIS OBSIP, 2011). We made picks of main body wave arrival times for 99 earthquakes belonging to two categories:

- Worldwide earthquakes with $M_W \geq 7.0$ during July 2011 – July 2013 period;
- Moderate earthquakes at local and regional distances during August 2013 – October 2015 period.

The parametric data obtained from Luke's work have been included in the ISC Bulletin. For a fair proportion of them, the accuracy of ISC hypocentre determinations has improved thanks to increased station azimuthal coverage and additional arrival times recorded closer to epicentres. A report on this work (Di Giacomo *et al.*, 2016b) was made available at ZENODO.

FINANCE

The detailed financial statements of the ISC for 2016 were audited by Wilkins Kennedy (previously known as Griffins) Chartered Accountants (Newbury UK) and approved by Prof. John Woodhouse of the ISC Executive Committee. These statements present the state of the ISC's financial affairs as at 31st December 2016.

INCOME

In 2016, the ISC had a total income of £871,811 from 63 Membership contributions, grants for special projects and general sponsorship. We were pleased to welcome three new member institutions during 2016: University of Brasilia, the Earth Observatory of Singapore and Korea Earthquake Administration. The grants and sponsorship are listed as Other Income and amount to 25.5% of the total income. The providers of these funds are itemised on page 7 of the accounts. Interest on ISC bank accounts is included in the Other Income. NSF funds and some other grants have been split between 2016 and 2017.

The exchange rate between the UK £ and US $ fell throughout the year from £1=$1.47 at the beginning of January, finishing at £1=$1.23 at the end of December. The ISC gained £4,509 on foreign exchange in 2016, an improvement on the loss of £12,235 in 2015.

At the end of the year £84,230 had yet to be paid by members but at the time of writing this report £5,632 had been received and £17,900 written off as bad debts leaving £60,698 outstanding, £48,360 being due from just two members: INGV in Italy and NCS in India.

EXPENDITURE

77% of ISC expenditure was committed to personnel costs, the same percentage as in 2015. During the year we saw the departure of two and arrival of two new members of staff. The staff costs include salaries, pension contributions, and recruitment of new staff. The ISC salaries continue to follow the scales adopted in 2015 and approved by the Executive Committee.

Building expenses increased in 2016, primarily due to the installation of a new roof and ceiling tiles as well as improvements made in the kitchen/lunch area. Staff travel and computer costs increased but VBAS and Other Costs decreased considerably. As in previous years, staff travelled to several countries to attend meetings and increase the profile of the ISC, take part in project meetings and also to seek new data and future funding.

The Visual Bulletin Analysis System (VBAS) project has been financially administered by Oxford University, with monetary contributions provided by UK KTP Programme (⅔ of the total budget) and the ISC (⅓ of the total). The latter is listed in the ISC Accounts as the VBAS costs.

RESERVES

The ISC's expenditure during 2016 exceeded its income by £31,989. As a result the total reserves, comprising cash in the bank, value of building and land, money owed to the ISC (debtors) minus money the ISC owes (creditors) fell to £807,288; this includes money ear-marked for on-going projects. The Contingency Fund stands at £30,000 in accordance with the wish of the ISC Governing Council. The ISC General Reserve of £777,288 is within British guidelines for charitable organizations.

CASH FLOW

The cash flow in Fig. 30 shows receipts and expenditure using dates when transactions were recorded at the bank and the bank balances where US Dollars and Euros are converted to Sterling using the exchange rate at the end of each month.

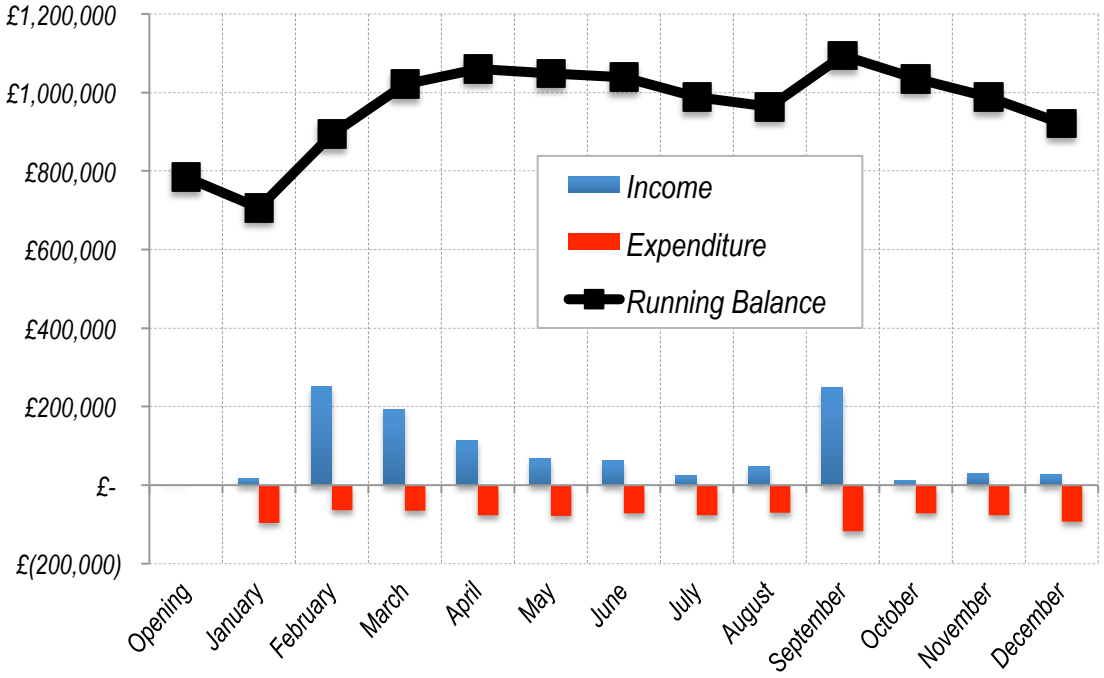


Figure 30. *Income/Expenditure cash flow and running cash balance during 2016*

In 2016, the ISC was fortunate not to experience problems with its cash flow and wishes to thank its Members and Sponsors for their continuing support. We would also like to thank those organizations that make their payment promptly and accurately when invoices are sent during the year.

SCIENTIFIC LIAISONS

VISITORS to the ISC

The following geophysicists visited ISC premises in Thatcham during the year:

- Marcelo Assumpcao, University of Sao Paulo, *Brazil*
- John Adams, NRCAN, *Canada*
- Fuqiong Huang, CENC/CEA, *China*
- Bertrand Delouis, University of Nice, *France*
- Reinhard Mittag, TU Bergakademie Freiberg, *Germany*
- Peter Suhadolc, University of Trieste, *Italy*
- Kenji Satake, ERI/University of Tokyo, *Japan*
- Johannes Schweitzer, NORSAR, *Norway*
- Przemas Kowalski, Polish Academy of Sciences, *Poland*
- Adi Richard Hazan, Analycat, *South Africa*
- Florian Hasslinger, SED/ETH, *Switzerland*
- Paiboon Nrannim, WTE, Thailand
- Sonti Dumrongsilp, WTE, Thailand
- Chris Potts, Guralp Systems, *UK*
- Emma Seymour, Guralp Systems, *UK*
- Stephen Hicks, Guralp Systems, *UK*
- Hannah Peters, Guralp Systems, *UK*
- Stuart Allardice, Guralp Systems, *UK*
- Clare Sweeney, Guralp Systems, *UK*
- Tarje Nissen-Meyer, Oxford University, *UK*
- Karin Sigloch, Oxford University, *UK*
- John Woodhouse, Oxford University, *UK*
- Min Chen, OeRC, Oxford University, *UK*
- Simon Walton, OeRC, Oxford University, *UK*
- Alice Walker, ONR Expert Panel, *UK*
- Shamita Das, Oxford University, *UK*
- Carol Tully, formerly ISC, *UK*
- David McGregor, formerly ISC, *UK*
- Anthony Hughes, formerly ISC, *UK*
- Carol Tubby, formerly ISC, *UK*
- Chris Browitt, University of Edinburgh, *UK*
- Goran Ekström, Columbia University, *USA*
- Bob Engdahl, University of Colorado, Boulder, *USA*

CONFERENCES, MEETINGS, WORKSHOPS, TRAINING COURSES

Members of the ISC staff presented at the following conferences, meetings and workshops:

- LACSC, San Jose, *Costa Rica*
- AfSC, Luxor-Aswan, *Egypt*
- Gorkha Earthquake Conference, New Delhi, *India*
- ESC, Trieste, *Italy*
- ASC/AEES, Melbourne, *Australia*
- JpGU-AGU, Makuhari, *Japan*
- GS RAS International Seismology School, Cholpon-Ata, *Kyrgyzstan*
- Problems of Modern Seismology, Tashkent, *Uzbekistan*
- CTBTO Conference on Monitoring Nuclear Tests, Almaty, *Kazakhstan*
- IUGG Assembly, Prague, *Czech Republic*
- Nordic Seismology Seminar, Reykjavik, *Iceland*
- Impact Forecasting Revealed, London, *United Kingdom*

ISC STAFF VISITING OTHER INSTITUTIONS

Often with the help of the hosting institution, members of the ISC staff visited and, where appropriate, gave a presentation to the staff of:

- University of Melbourne, Melbourne, *Australia*
- CTBTO, Vienna, *Austria*
- GFZ, Potsdam, *Germany*
- India Meteorological Department, New Delhi, *India*
- National Centre for Seismology, New Delhi, *India*
- OYO Geophysical Corporation, Tokyo, *Japan*
- Kazakstan National Data Centre, Almaty, *Kazakhstan*
- Seismological Experimental and Methodological Expedition, Almaty, *Kazakhstan*
- Mavlyanov Institute of Seismology, Tashkent, *Uzbekistan*
- GS RAS, Obninsk, *Russia*
- Guralp Systems, Aldermaston, *UK*
- Oxford University, Earth Science Department, Oxford, *UK*
- Oxford e-Research Centre, Oxford, *UK*

ISC PRIZE for OXFORD UNIVERSITY STUDENTS

A few years ago the ISC established a small annual Prize in Mathematics and Geophysics (£200 and traditional ISC coffee mug) for the best first year student at the Earth Science Department of its home institution – the University of Oxford. In 2016, the prize was given to Ms Carrie Holloway, the student with the best exam results in geophysics and mathematics. By awarding this prize the ISC hopes to attract Oxford University students to take note of the

ISC services right from their first year, support the ISC in the future and perhaps even help the ISC in fulfilling its mission.

USGS COMCAT TELECALLS

As part of its long and established cooperation with USGS, the ISC staff took part in a series of late night (in UK) telephone conferences run by the USGS headquarters in Reston and aimed to observe, discuss and advise on the formation of the USGS Comprehensive Catalog (ComCat). ComCat is to be widely used by the US and other researchers. ComCat combines the NEIC catalogues with bulletins of local US networks. The historical part of ComCat will benefit from the data in the ISC-GEM Catalogue.

SCIENTIFIC PAPERS PUBLISHED by ISC STAFF

Di Giacomo, D., and D.A. Storchak, 2016a. A scheme to set preferred magnitudes in the ISC Bulletin, J. Seism., 20(2), 555-567, doi: 10.1007/s10950-015-9543-7

D. Di Giacomo1 L. Cottell, J. Harris, E. Entwistle and D.A. Storchak, 2016b. Adding seismic picks from Ocean Bottom Seismometers (OBS) into the ISC Bulletin: the example of the "7D Cascadia Initiative Experiment, OBS Component", doi: 10.5281/zenodo.376624

Weston, J. and Shirzaei, M., 2016. Combining GPS and repeating earthquakes for a high resolution analysis of subduction zone coupling, Tectonophysics, 667, 37-47, doi: 10.1016/j.tecto.2015.11.009

Storchak, D.A., Di Giacomo, D. and J. Harris, 2016. ISC contribution to global and regional seismic hazard assessment and civil engineering. In: Proceedings of the Australian Earthquake Engineering Society 2016 Conference, Nov 25-27, Melbourne, Vic, in print.

OTHER REFERENCES USED IN THIS REPORT

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BAAS, 1913-1917. British Association for the Advancement of Science, Seismological Committee, monthly bulletins.

Bondár, I., and D. Storchak, Improved location procedures at the International Seismological Centre, 2011. *Geophys. J. Int*., 186, 1220-1244.

Bondár, I., E.R. Engdahl, A. Villaseñor , J. Harris and D.A. Storchak, 2015. ISC-GEM: Global Instrumental Earthquake Catalogue (1900-2009): II. Location and seismicity patterns, *Phys. Earth Planet. Int.,* 239, 2-13, doi: 10.1016/j.pepi.2014.06.002.

Di Giacomo, D., J. Harris, A. Villaseñor , D.A. Storchak, E.R. Engdahl, W.H.K. Lee and the Data Entry Team, 2015. ISC-GEM: Global Instrumental Earthquake Catalogue (1900-2009),

I. Data collection from early instrumental seismological bulletins, *Phys. Earth Planet. Int.,* 239, 14-24, doi: 10.1016/j.pepi.2014.06.003.

Di Giacomo, D., I. Bondár, D.A. Storchak, E.R. Engdahl, P. Bormann and J. Harris, 2015. ISC-GEM: Global Instrumental Earthquake Catalogue (1900-2009): III. Re-computed MS and mb, proxy MW, final magnitude composition and completeness assessment, *Phys. Earth Planet. Int.,* 239, 33-47, doi: 10.1016/j.pepi.2014.06.005.

Ekström, G., Nettles, M., and Dziewonski, A.M., 2012. The global CMT project 2004–2010: Centroid-moment tensors for 13,017 earthquakes, *Phys. Earth Planet. Int*., 200-201, 1-9.

Engdahl, E.R., van der Hilst, R. and Buland, R., 1998. Global teleseismic earthquake relocation with improved travel times and procedures for depth determination, *Bull. Seism. Soc. Am.*, 88, 722-743.

IRIS OBSIP (2011): Cascadia Initiative Community Experiment - OBS Component. International Federation of Digital Seismograph Networks. Other/Seismic Network. doi:10.7914/SN/7D_2011.

ISS, 1918-1963. International Seismological Summary, annual volumes.

Kennett, B. L. N., Engdahl, E. R., and Buland, R., 1995. Constraints on seismic velocities in the Earth from traveltimes, *Geophys. J. Int*., 122, 108-124.

Storchak, D.A., D. Di Giacomo, E.R. Engdahl, J. Harris, I. Bondár, W.H.K. Lee, P. Bormann and A. Villaseñor, 2015. The ISC-GEM Global Instrumental Earthquake Catalogue (1900-2009): Introduction, *Phys. Earth Planet. Int.,* 239, 48-63, doi: 10.1016/j.pepi.2014.06.009.

SCIENTIFIC PAPERS PUBLISHED in 2016 that USED the ISC DATA

This list is a result of a special effort to put together a collection of scientific papers that used ISC data and published in 2016. The list is by no means exhaustive. The ISC has become such a familiar name that many researchers unfortunately fail to reference the ISC when using the ISC data.

We have searched Google Scholar for scientific papers that refer to the ISC data. We used the exact phrases "International Seismological Centre", "International Seismological Center", "ISC-GEM", "ISC-EHB" and "EHB"+"seismic" for papers appearing in 2016. No doubt many more references can be found by using different search phrases.

Dynamics of Intra-Continental Convergence Between the Western Tarim Basin and Central Tien Shan Constrained by Centroid Moment Tensors of Regional … GD Huang, SW Roecker, V Levin, H Wang, Z Li - Geophysical Journal International, 2016. Abstract Among the outstanding tectonic questions regarding the convergence between the Tien Shan and Tarim basin in northwestern China are the manner in which deformation is accommodated within their lithospheres, and the extent that the Tarim lithosphere

The new empirical magnitude conversion relations using an improved earthquake catalogue for Turkey and its near vicinity (1900-2012). FT KADIRIOĞLU, RF Kartal - Turkish Journal of Earth Sciences, 2016. Abstract: Empirical magnitude conversion relationships are one of the important parameters for not only seismological studies but also seismic hazard analysis and development of the attenuation relationships. Particularly, for seismic hazard analysis, conversion of various

An earthquake catalogue (2200 BC to 2013) for seismotectonic and seismic hazard assessment studies in Egypt R Sawires, JA Peláez, RE Fat-Helbary, HA Ibrahim - Earthquakes and their impact …, 2016 Of all natural hazards, earthquakes are those which historically have caused the most extensive impact and disruption in terms of damage to infrastructure, human-casualties and economic losses. They are the expression of a continuing evolution of the Earth Planet and

An improved earthquake catalogue (M≥ 4.0) for Turkey and its near vicinity (1900–2012) FT Kadirioğlu, RF Kartal, T Kılıç, D Kalafat, TY Duman… - Bulletin of Earthquake …, 2016 Abstract Many catalogues, agency reports and research articles have been published on seismicity of Turkey and its surrounding since 1950s. Given existing magnitude heterogeneity, erroneous information on epicentral location, event date and time, this past

Spatial variations in late Quaternary slip rates along the Doruneh Fault System (Central Iran) Y Farbod, E Shabanian, O Bellier, MR Abbassi… - Tectonics, 2016 Abstract The Doruneh Fault System (DFS) is one of the major active strike-slip faults in the Arabia-Eurasia collision zone. Despite its geological activity, no large (M≥ 6.5) historical or instrumental earthquakes have been recorded along it. To date, the rate and distribution of

The long-wavelength mantle structure and dynamics and implications for large-scale tectonics and volcanism in the Phanerozoic S Zhong, X Liu - Gondwana Research, 2016 Abstract The Earth's lower mantle structure, as revealed by seismic tomography studies, is best characterized by two large low seismic velocity provinces (ie, LLSVP) beneath Africa and Pacific and their surrounding, circum-Pacific seismically fast anomalies. This mantle

P and S wave tomography of Japan subduction zone from joint inversions of local and teleseismic travel times and surface-wave data X Liu, D Zhao - Physics of the Earth and Planetary Interiors, 2016 Abstract We determined P and S wave velocity tomography of the Japan subduction zone down to a depth of 700 km by conducting joint inversions of a large number of high-quality arrival-time data of local earthquakes and teleseismic events which are newly collected for

Constraining potential earthquake sources from the geophysical data VV Spichak - Izvestiya. Physics of the Solid Earth, 2016 Abstract The spatial models describing the physico-mechanical properties of the rocks within the seismically active segment of the Altai-Sayan region are constructed from the ground-based geophysical data. The comparative analysis of their probability density functions at

Application of a characteristic periods-based (CPB) approach to estimate earthquake-induced displacements of landslides through dynamic numerical modelling S Martino, L Lenti, J Delgado, J Garrido… - Geophysical Journal …, 2016 Abstract The interaction between seismic waves and slopes is an important topic to provide reliable scenarios for earthquake-(re) triggered landslides. The physical properties of seismic waves as well as slope topography and geology can significantly modify the local

Seismic hazard assessment of the Kivu rift segment based on a new seismotectonic zonation model (Western Branch, East African Rift system) D Delvaux, JL Mulumba, MNS Sebagenzi, SF Bondo… - Journal of African Earth …, 2016 Abstract In the frame of the Belgian GeoRisCA multi-risk assessment project focusing on the Kivu and northern Tanganyika rift region in Central Africa, a new probabilistic seismic hazard assessment has been performed for the Kivu rift segment in the central part of the

Pipeline Processing with an Iterative, Context-based Detection Model T Kvaerna, DB Harris, SJ Gibbons, D Dodge – 2016 Abstract: Under existing detection pipelines, seismic event hypotheses are formed from a parametric description of the waveform data obtained from a single pass over the incoming data stream. The full potential of signal processing algorithms is not being exploited due to

Identification of seismically susceptible areas in western Himalaya using pattern recognition A Sinvhal, HR Wason - Journal of Earth System Science, 2016 Abstract Seismicity in the western Himalayas is highly variable. Several historical and instrumentally recorded devastating earthquakes originated in the western Himalayas which are part of the Alpine-Himalayan belt. Earthquakes cause tremendous loss of life and to the

Seismicity and state of stress in the central and southern Peruvian flat slab A Kumar, LS Wagner, SL Beck, MD Long, G Zandt… - Earth and Planetary …, 2016 Abstract We have determined the Wadati–Benioff Zone seismicity and state of stress of the subducting Nazca slab beneath central and southern Peru using data from three recently deployed local seismic networks. Our relocated hypocenters are consistent with a flat slab

CARACTERIZACIÓN SISMOTECTÓNICA DE LA REGIÓN DEL VALLE DEL CAUCA Y ZONAS ALEDAÑAS A PARTIR DE MECANISMOS FOCALES DE … EDJ Salcedo-Hurtado, JL Pérez - Boletín de Geología, 2016 RESUMEN El presente trabajo analiza el mecanismo focal de 49 terremotos con magnitud Mw≥ 4, 8 en la región del Valle del Cauca y zonas aledañas, durante el periodo 1978–2010. Las soluciones fueron tomadas de los catálogos del Centro Internacional de

Petrography and Whole-Rock Geochemistry of the Oligocene-Miocene Khojak Formation Khojak-Pishin Belt, Pakistan: Implications on Provenance and Source Area … DM Kakar, AK Kasi, AM Kassi, H Friis, M Mohibullah… - Journal of Himalayan Earth …, 2016 Abstract The Oligocene and Early Miocene Khojak Formation represent a deltaic to sub-marine fan succession in the Khojak-Pishin flysch belt within the Katawaz basin of Pakistan. The sandstone within this succession is dominated by sedimentary and metamorphic clasts

30 Ekim 1983 Horasan-Narman Depremi (Ms= 6.8) Yırtılma Özelliklerinin Telesismik Sonlu-Fay Modellemesi Yoluyla İncelenmesi A Güneş, H Durmuş, M Utkucu - Yerbilimleri Dergisi, 2016 ABSTRACT The October 30, 1983 Horasan-Narman earthquake (Ms= 6.8) occurred along the Northeast Anatolian Fault Zone in Eastern Turkey. Previous point-source waveform analysis by several seismological organisations and researchers have indicated that the

Kuzey Anadolu Fay Zonu Üzerinde Koyulhisar (Sivas) ve Yakın Çevresindeki Fayların Kinematik Özellikleri M Demirel, O Tatar, F Koçbulut - Geological Bulletin of Turkey, 2016 ABSTRACT The study area is located on the eastern part of the North Anatolian Fault Zone (NAFZ) around the Koyulhisar (Sivas) region. The region is represented by a 6-8 km wide and 32 km long deformation belt. This belt is divided into 5 fault segments by Toprak (1988)

PENENTUAN ARAH PATAHAN YANG TERDAPAT DI PULAU TIMOR DAN SEKITARNYA MENGGUNAKAN MEKANISME SUMBER 3D GEMPABUMI JN Mohamad - Jurnal Fisika Sains dan Aplikasinya, 2016 Abstract Determination of Fault Directional at Timor Island and surroundings using 3D Focal Mechanism. Has been done a reseach on determining of fault directional at Timor Island and surrounding using 3D focal mechanisms earthquake from US Geological

KAJIAN SEISMISITAS DAN PERIODE ULANG GEMPA BUMI DI ACEH R Tauladani, N Ismail, D Sugianto - Jurnal Ilmu Kebencanaan: Program …, 2016 Abstract: Indonesia is one of the country that is very prone to the tectonic earthquake and tsunami, in particular Aceh areas that face directly with the confluence of two highly active tectonic plates which causes the frequent seismic activity in the area of research. The aim of

Two-stage composite megathrust rupture of the 2015 Mw8. 4 Illapel, Chile, earthquake identified by spectral-element inversion of teleseismic waves SJ Lee, TY Yeh, TC Lin, YY Lin, TRA Song, BS Huang - Geophysical Research …, 2016 Abstract The M w 8.4 Illapel earthquake occurred on 16 September was the largest global event in 2015. This earthquake was not unexpected because the hypocenter was located in a seismic gap of the Peru-Chile subduction zone. However, the source model derived from 3-

Path-specific, dispersion-based velocity models and moment tensors of moderate events recorded at few distant stations: Examples from Brazil and Greece F Dias, J Zahradník, M Assumpção - Journal of South American Earth Sciences, 2016

Abstract Centroid moment tensor (CMT) determination in intraplate regions like Brazil can be very difficult, because earthquakes are often recorded just at few and distant stations. This paper introduces a methodology for datasets like that. The methodology is based on

Seismic structure of the crust and uppermost mantle beneath Caucasus based on regional earthquake tomography I Zabelina, I Koulakov, I Amanatashvili, S El Khrepy… - Journal of Asian Earth …, 2016 Abstract We present a new seismic model of the crust beneath the Caucasus based on tomographic inversion of P and S arrival times from earthquakes occurred in the region recorded by regional seismic networks in the Caucasian republics. The resulting P and S

Earthquake induced soil liquefaction index of Duzce province, in Turkey using probabilistic and statistical methods A Ateş – 2016 The 12 November 1999 Duzce earthquake (the earthquake had magnitudes MW of 7.2) in Turkey caused a huge destruction and hazard for Duzce in Turkey sites in the Western Black Sea Region. In the study area, the main reason for destruction is observed due

A MAGNITUDE SCALE FOR EGYPTIAN NATIONAL SEISMIC NETWORK (ENSN) SSR MOUSTAFA, A DEIF ABSTRACT: There are numerous attempts in many countries to express earthquake magnitude as a measure of relative energy rating of seismic phenomena. ENSN consists of 63 seismic stations, which equipped mainly by Nanometrics instruments. Most of ENSN

Seismogram Analysis of Earthquakes in Sumatra-Java at HYB Observatory Station BJ Santosa - Indonesian Journal of Physics, 2016 Abstract The S wave velocity across the earth structure under Indian Ocean has been investigated through seismogram analysis in the time domain and three Cartesians components simultaneously from earthquakes occurred in Sumatra in which the

Tectonic earthquakes of October 22, 2005 and March 28, 2013 in the north of the Russian plate AN Morozov, NV Vaganova, YV Konechnaya - Izvestiya, Physics of the Solid Earth, 2016 Abstract—The data from seismic stations of the Arkhangelsk network and the networks in the neighboring territories are analyzed for refining the focal parameters of the tectonic earthquakes recorded in the north of the Russian plate on October 22, 2005 (M= 2.9) and

Multi-seismotectonic models, present-day seismicity and seismic hazard assessment for Suez Canal and its surrounding area, Egypt MA El-Eraki, A El-aziz, KA El-aal, SI Mostafa - Bulletin of Engineering Geology and …, 2016 Abstract Suez Canal is the most important navigational water stream in the world. It separates the eastern part of the Nile Delta from northern Sinai and controls 40% of ship movement in the world. There is also the new Suez Canal project, which is one of the most

A local magnitude scale for crustal earthquakes in Italy M Di Bona - Bulletin of the Seismological Society of America, 2016 Abstract In this study, a new local magnitude (ML) scale is derived for the Italian region from the analysis of seismic signals recorded by a dense broadband network between 2003 and 2009. The ML computation is performed by measuring peak amplitudes of synthetic Wood–

The 2013 Wyoming upper mantle earthquakes: Tomography and tectonic implications X Wang, D Zhao, J Li - Journal of Geophysical Research: Solid Earth, 2016 Abstract On 21 September 2013 two earthquakes (M 4.8 and 3.0, focal depths> 70 km) occurred in the lithospheric mantle beneath central Wyoming, which provide a rare opportunity to investigate the lithosphere rheology and dynamics.

The seismotectonics of Southeastern Tanzania: Implications for the propagation of the eastern branch of the East African Rift GD Mulibo, AA Nyblade - Tectonophysics, 2016 Abstract Seismicity patterns and focal mechanisms in southeastern Tanzania, determined from data recorded on temporary and permanent AfricaArray seismic stations, have been used to investigate the propagation direction of the Eastern branch of the East African Rift

TIME-DEPENDENT SEISMIC HAZARD ABOVE THE SOUTH AMERICA SUBDUCTION ZONE IN CENTRAL AND SOUTHERN CHILE I Wong, M Dober, P Thomas, E Nemser, J Bott Abstract The Peru-Chile portion of the South America subduction zone is one of the most seismically active regions in the world and the source of some of the largest known earthquakes, including the 1960 moment magnitude (M) 9.5 Great Chile earthquake and

Intermediate-term variations in 200 years seismicity of south of Iran M Nemati - Geomatics, Natural Hazards and Risk, 2016 remarkable variations in moderate–large seismicity during the last two centuries in Zagros and eastern Iran seismotectonic provinces have chronically been investigated, in this study. The time variations of seismic hazards [macroseismic maximum intensity and scalar

SPATIAL ANALYSIS OF EARTHQUAKES IN IRAQ USING STATISTICAL AND DATA MINING TECHNIQUES EAMS Al-Heety - IRAQI GEOLOGICAL JOURNAL (IGJ) ABSTRACT Statistical and data mining techniques (DMTs) are applied to an earthquakes catalogue of Iraq to study the spatial distribution pattern of earthquakes over the period from 1900 to 2010. The employed

The 11 October 2010 Novaya Zemlya Earthquake: Implications for Velocity Models and Regional Event Location SJ Gibbons, G Antonovskaya, V Asming… - Bulletin of the …, 2016 Abstract Characterizing the seismicity of Novaya Zemlya and the surrounding Arctic seas requires accurate event-location estimates. Low-magnitude events in this region are currently observed only by a small number of stations in the European Arctic, with a large

Seismic hazard assessment of Western Coastal Province of Saudi Arabia: deterministic approach F Rehman, SM El-Hady, AH Atef, HM Harbi - Earthquake Science, 2016 Abstract Seismic hazard assessment is carried out by utilizing deterministic approach to evaluate the maximum expected earthquake ground motions along the Western Coastal Province of Saudi Arabia. The analysis is accomplished by incorporating seismotectonic

Long-Term Seismic Quiescences and Great Earthquakes in and Around the Japan Subduction Zone Between 1975 and 2012 K Katsumata - Pure and Applied Geophysics, 2016 Abstract An earthquake catalog created by the International Seismological Center (ISC) was analyzed, including 3898 earthquakes located in and around Japan between January 1964 and June 2012 shallower than 60 km with the body wave magnitude of 5.0 or larger.

Prediction of maximum earthquake magnitude for northern Vietnam region based on the gev distribution VT Hoan, NT Lu, M Rodkin, NH Tuyen, PTT Hang… - Vietnam Journal of Earth …, 2016 ABSTRACT The present work is a continuation and improvement of the application of the generalized extreme value distribution to study the seismicity of the Southeast Asia. We have applied the generalized extreme value distribution (GEV) method to estimate maximum

Seismic Underground Characteristics beneath Izmir Geothermal Area C Ozer, O Polat - NORTH ICELAND, 2016 Izmir shows high micro earthquake activity and presents important geothermal areas in the Aegean region of Turkey, Western Anatolia. We bring a new perspective of velocity structure of the study area using local earthquake tomography (LET). We investigated crustal features

A review on application of data mining techniques to combat natural disasters S Goswami, S Chakraborty, S Ghosh, A Chakrabarti… - Ain Shams Engineering …, 2016 Abstract Thousands of human lives are lost every year around the globe, apart from significant damage on property, animal life, etc., due to natural disasters (eg, earthquake, flood, tsunami, hurricane and other storms, landslides, cloudburst, heat wave, forest fire).

Tomography of the source zone of the 2015 M 7.8 Nepal earthquake W Wei, D Zhao - Physics of the Earth and Planetary Interiors, 2016 Abstract We conducted P-wave anisotropic tomography beneath Nepal and surrounding areas to clarify the causal mechanism of the 25 April 2015 Nepal earthquake (Mw 7.8) and dynamic processes of the India-Asia collision zone. Our results show that hypocenters of the

Rapidly estimated seismic source parameters for the 16 September 2015 Illapel, Chile Mw 8.3 earthquake L Ye, T Lay, H Kanamori, KD Koper - Pure and Applied Geophysics, 2016 – Springer The region just to the south (32°S to 34.5°S) ruptured most recently in the 9 July 1971 [M S 7.9, M W 7.8, (ISC-GEM)] and 3 March 1985 [M S 7.8, M W 7.9 (CMT)] Valparaíso earthquakes as well as previously in the great 17 August 1906 (M S 8.4) earthquake (eg, Comteet

An improved earthquake catalogue (M≥ 4.0) for Turkey and its near vicinity (1900–2012) FT Kadirio□lu, RF Kartal, T Kılıç, D Kalafat… - Bulletin of Earthquake …, 2016 – Springer ... ISS. Bulletins of International Seismological Summary, 1918–1963. ISC-GEM. ISC-GEM Global Instrumental Earthquake Catalogue (1900–2009). BCIS. Determination Preliminaria, Bureau Central International Seismologie, 1930–1975. CGS. ...

Operational earthquake forecasting in Europe: progress, despite challenges JD Zechar, W Marzocchi, S Wiemer - Bulletin of Earthquake Engineering, 2016 - n.ethz.ch ... 2012) from 1000 to 1899 and the ISC-GEM instrumental earthquake catalog (http://www.isc.ac.uk/iscgem/) (Storchak et al. 2013, 2015; Bondár et al. 2015; Di Giacomo et al. 2015a, b; Lee and Engdahl 2015) from 1900 to 2011. ...

Recurring large deep earthquakes in Hindu Kush driven by a sinking slab Z Zhan, H Kanamori - Geophysical Research Letters, 2016 - Wiley Online Library ... Kush earthquakes at intermediate depth the larger shocks are abnormally frequent, … Most of the epicenters are at nearly the same point near 36.5 N, 70.5 E (230 km)." The Global Centroid-Moment-Tensor (GCMT) catalog and the recently compiled ISC-GEM catalog [Storchak ...

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An updated and unified earthquake catalogue for the Western Balkan Region S Markusic, Z Gülerce, N Kuka, L Duni… - Bulletin of …, 2016 - search.proquest.com ... Eqs. 13: MW 0:80 Mms 1:31 4:0 Mms\5:4 1. MW 0:70 Mms 1:80 5:4 Mms\6:3 2. MW 1:04 Mms 0:33 6:3 Mms\8:1 3. The surface wave magnitude MS is proven to be a good estimator of MW since it scales rather well in a wide range of magnitudes (ISC-GEM 2012). ...

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The 2015 Mw 7.1 earthquake on the Charlie-Gibbs transform fault: Repeating earthquakes and multimodal slip on a slow oceanic transform K Aderhold, RE Abercrombie - Geophysical Research Letters, 2016 - Wiley Online Library ... time. Longitudes are from ComCat; magnitudes are from ISC-GEM/Pasadena (M s : 1923, 6.5; 1941, 6.25; 1954, 6.5), Kanamori and Stewart [1976] (M w from M 0 : 1967, 7.0; 1974, 7.0), and ComCat (M w : 1998, 6.8; 2015, 7.1). ...

Evaluation of seismic hazard at the northwestern part of Egypt
M Ezzelarab, MMF Shokry, AME Mohamed… - Journal of African Earth …, 2016 – Elsevier ... International Seismic agencies: The National Earthquake Information Center (NEIC) (http://earthquake.usgs.gov/earthquakes/); and The ISC-GEM Global Instrumental Earthquake Catalogue (http://www.isc.ac.uk/iscgem/citing.php). II. ...

New constraints shed light on strike-slip faulting beneath the southern Apennines (Italy): The 21 August 1962 Irpinia multiple earthquake P Vannoli, F Bernardi, B Palombo, G Vannucci… - Tectonophysics, 2016 – Elsevier ... Finally, this earthquake was also included in the ISC-GEM Global Instrumental Earthquake Catalogue (Storchak et al., 2013), as the result of a special effort to improve currently existing bulletin data of large global earthquakes by means of modern location algorithms and Earth ...

Residual polar motion caused by coseismic and interseismic deformations from 1900 to present G Cambiotti, X Wang, R Sabadini… - Geophysical Journal …, 2016 - academic.oup.com ... In this framework, we first simulate the polar motion caused by only coseismic deformations during the longest period available of instrumental seismicity, from 1900 to present, using both the CMT and ISC-GEM catalogues. ...

The M w 8.1 2014 Iquique, Chile, seismic sequence: a tale of foreshocks and aftershocks S Cesca, F Grigoli, S Heimann, T Dahm… - Geophysical Journal …, 2016 - academic.oup.com

Earthquake potential and magnitude limits inferred from a geodetic strain-rate model for southern Europe Y Rong, P Bird, DD Jackson - … to the Monthly Notices of the …, 2016 - academic.oup.com

Probabilistic seismic hazard map of Papua New Guineaf
H Ghasemi, C McKee, M Leonard, P Cummins… - Natural …, 2016 - search.proquest.com ... The release of the ISC-GEM earthquake catalogue in 2013 has provided basic earthquake details for the region with a consistent moment magnitude. ... 3 Earthquake catalogue processing. In this study the ISC-GEM catalogue (Storchak et al. ...

Core Concept: Tectonic tremors could offer insights into the big shakers D Venton - Proceedings of the National Academy of …, 2016 - National Acad Sciences ... deep beneath the San Andreas Fault. Science 307(5708):389. . Abstract/FREE Full Text. ↵: ISC. (2015) ISC-GEM Global Instrumental Earthquake Catalogue (1900-2009), Version 2.0 (International Seismological Centre, UK).

Earthquake rate and magnitude distributions of great earthquakes for use in global forecasts YY Kagan, DD Jackson - Geophysical Journal International, 2016 - academic.oup.com ... The forecast was optimized to fit the GCMT data from 2005 through 2012, but it also fit well the earthquake locations from 1918 to 1976 reported in the International Seismological Centre-Global Earthquake Model (ISC-GEM) global catalogue of instrumental and pre-instrumental ...

Exploring earthquake databases for the creation of magnitude-homogeneous catalogues: tools for application on a regional and global scale GA Weatherill, M Pagani, J Garcia - Geophysical Journal …, 2016 - academic.oup.com
... earthquake catalogue. Several existing high-quality earthquake databases, such as the ISC-GEM and the ISC Reviewed Bulletins, are harmonized into moment magnitude to form a catalogue of more than 562 840 events. This ...

The 16 April 2016, MW 7.8 (MS 7.5) Ecuador earthquake: A quasi-repeat of the 1942 MS 7.5 earthquake and partial re-rupture of the 1906 MS 8.6 Colombia–Ecuador … L Ye, H Kanamori, JP Avouac, L Li, KF Cheung… - Earth and Planetary …, 2016 - Elsevier
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PROBABILISTIC SEISMIC HAZARD ANALYSIS: ISSUES AND
M Pagani, J Garcia, V Poggi, G Weatherill - 2016 - researchgate.net ... Using this tool is now possible to combine a high quality catalogue like the ISC-GEM (Storchak et al., 2015) covering the mid and high magnitude range with other global and regional catalogues (eg the GCMT) and local catalogues containing magnitudes in the mid and low ...

Updated Tsunami Catalog for the Jalisco-Colima Coast, Mexico, Using Data from Historical Archives R Castillo-Aja… - Seismological Research …, 2016 - srl.geoscienceworld.org

Transcurrent reactivation of Australia's western passive margin: An example of intraplate deformation from the central Indo-Australian plate JV Hengesh, BB Whitney - Tectonics, 2016 - Wiley Online Library ... See Figure 2 for a plot of well-located events from the ISC-GEM catalog [Storchak et al., 2013].Basin boundaries are from Geoscience Australia [Stewart et al., 2013]. ... ISC-GEM, International Seismological Centre-Global Earthquake Model. KLM, Kuala Lumpur, Malaysia. ...

Systematic difference between first-motion and waveform-inversion solutions for shallow offshore earthquakes due to a low-angle dipping slab S Takemura, K Shiomi… - Earth, Planets …, 2016 - earth-planets-space.springeropen. … ... 2002; Obara 2002; Shiomi et al. 2006, 2008; Shelly et al. 2007; Hirose et al. 2008; Citak et al. 2012; Matsuzawa et al. 2013; Kim et al. 2016; Kita and Matsubara 2016; Takagi et al. 2016). Referring from combined catalog of the ISC–GEM catalog (Storchak et al. ...

Geophysical constraints on geodynamic processes at convergent margins: A global perspective IM Artemieva, H Thybo, A Shulgin - Gondwana Research, 2016 – Elsevier Convergent margins, being the boundaries between colliding lithospheric plates, form the most disastrous areas in the world due to intensive, strong seismicity.

Relocalizing a historical earthquake using recent methods: The 10 November 1935 Earthquake near Montserrat, Lesser Antilles
P Niemz, D Amorèse - Journal of South American Earth Sciences, 2016 – Elsevier ... A similar approach in regard to the global seismicity is underway at the International Seismological Centre (ISC) which produces and maintains the ISC-GEM Catalog as an authoritative source for global earthquake locations. ...

Imaging active faulting in a region of distributed deformation from the joint clustering of focal mechanisms and hypocentres: Application to the Azores–western … S Custódio, V Lima, D Vales, S Cesca, F Carrilho - Tectonophysics, 2016 – Elsevier The matching between linear trends of hypocentres and fault planes indicated by focal mechanisms (FMs) is frequently used to infer the location and geometry of.

Tectonic interaction between the Pamir and Tien Shan observed by GPS A Zubovich, T Schöne, S Metzger, O Mosienko… - …, 2016 - Wiley Online Library ... Tien Shan region accommodates a higher deformation over a shorter distance compared to the Tibetan Plateau [Schmidt et al., 2011; van Hinsbergen et al., 2011] and is capable to produce magnitude 7 earthquakes in nearly decadal repeat times (ISC-GEM catalog) [Storchak ...

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Data-Driven Seismic-Hazard Models Prepared for a Seismic Risk Assessment in the Dead Sea Region
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RL Wheeler - Bulletin of the Seismological Society of America, 2016 - bssaonline.org Bulletin of the Seismological Society of America. Skip to main page content. ...

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VK Gahalaut, SS Martin, D Srinagesh, SL Kapil… - Tectonophysics, 2016 – Elsevier The 2016 Mw 6.7 Tamenglong earthquake (in the state of Manipur in northeastern India) on 4 January 2016 at 04:35 Indian Standard Time (3 January, 23:05 UTC) was.

Central Andean crustal structure from receiver function analysis
J Ryan, S Beck, G Zandt, L Wagner, E Minaya… - Tectonophysics, 2016 – Elsevier The Central Andean Plateau (15°–27°S) is a high plateau in excess of 3 km elevation, associated with thickened crust along the western edge of the Sout.

Travel time source-specific station corrections related to lithospheric structures in the Mediterranean region A Giuntini, V Materni, R Console, S Chiappini… - Journal of Seismology, 2016 We compare the locations obtained from arrival times collected by the International Seismological Centre from a network of regional and teleseismic stations for a cluster of Italian earthquakes with the locations of the same events obtained by the dense national

Subcrustal structure of the black sea basin from seismological data TB Yanovskaya, VS Gobarenko, TP Yegorova - Izvestiya. Physics of the Solid Earth, 2016 Abstract The P-wave travel time data from the earthquakes offshore and onshore around the Black Sea are used for the tomographic reconstruction of the three-dimensional (3D) velocity distribution in the lithosphere of the region. The preliminary refinement of the foci parameters

Faulting structure above the Main Himalayan Thrust as shown by relocated aftershocks of the 2015 Mw7. 8 Gorkha, Nepal, earthquake L Bai, H Liu, J Ritsema, J Mori, T Zhang, Y Ishikawa… - Geophysical Research …, 2016 Abstract The 25 April 2015, M w 7.8 Gorkha, Nepal, earthquake ruptured a shallow section of the Indian-Eurasian plate boundary by reverse faulting with NNE-SSW compression, consistent with the direction of current Indian-Eurasian continental collision. The Gorkha

Southeast Papuan crustal tectonics: Imaging extension and buoyancy of an active rift GA Abers, Z Eilon, JB Gaherty, G Jin, YH Kim… - Journal of Geophysical …, 2016 Abstract Southeast Papua hosts the world's youngest ultra-high-pressure (UHP) metamorphic rocks. These rocks are found in an extensional setting in metamorphic core complexes. Competing theories of extensional shear zones or diapiric upwelling have been

A detailed seismic zonation model for shallow earthquakes in the broader Aegean area. DA Vamvakaris, CB Papazachos, CA Papaioannou… - Natural Hazards & Earth …, 2016 Abstract. In the present work we propose a new seismic zonation model of area type sources for the broader Aegean area, which can be readily used for seismic hazard assessment. The definition of this model is based not only on seismicity information but incorporates all

Seismicity constraints on stress regimes along Sinai subplate boundaries AK Abdel-Fattah, SM Mogren, S Almadani - Studia Geophysica et Geodaetica, 2016 Abstract The relative movement between African, Arabian and Eurasian plates has significantly controlled the tectonic process of Sinai subplate region, although its kinematics and precise boundaries are still doubtful. The respective subplate bounded on both sides by

Fully probabilistic seismic source inversion-Part 2: Modelling errors and station covariances SC Stähler, K Sigloch - Solid Earth, 2016 Abstract Seismic source inversion, a central task in seismology, is concerned with the estimation of earthquake source parameters and their uncertainties. Estimating uncertainties is particularly challenging because source inversion is a non-linear problem. In a

Earthquake rate and magnitude distributions of great earthquakes for use in global forecasts YY Kagan, DD Jackson - Geophysical Journal International, 2016 Abstract We have obtained new results in the statistical analysis of global earthquake catalogues with special attention to the largest earthquakes, and we examined the statistical behaviour of earthquake rate variations. These results can serve as an input for updating our

Active normal faulting during the 1997 seismic sequence in Colfiorito, Umbria: Did slip propagate to the surface? ZK Mildon, GP Roberts, JPF Walker, LNJ Wedmore… - Journal of Structural …, 2016 Abstract In order to determine whether slip during an earthquake on the 26th September 1997 propagated to the surface, structural data have been collected along a bedrock fault scarp in Umbria, Italy. These collected data are used to investigate the relationship between

Structural–dynamic model of the Chersky seismotectonic zone (continental part of the Arctic–Asian seismic belt) LP Imaeva, VS Imaev, BM Koz'min - Journal of Asian Earth Sciences, 2016
Abstract To construct a model for modern geodynamics of the Chersky seismotectonic zone (continental part of the Arctic–Asian seismic belt) we analyzed the available data on its structural–

tectonic setting, depth structure, kinematics of active faults, morphotectonic

Restoration of clipped seismic waveforms using projection onto convex sets method J Zhang, J Hao, X Zhao, S Wang, L Zhao, W Wang… - Scientific reports, 2016 Abstract The seismic waveforms would be clipped when the amplitude exceeds the upper- limit dynamic range of seismometer. Clipped waveforms are typically assumed not useful and seldom used in waveform-based research. Here, we assume the clipped components of

Uppermost mantle structure of the Australian continent from Pn traveltime tomography W Sun, BLN Kennett - Journal of Geophysical Research: Solid Earth, 2016 Abstract Past studies of the seismic structure of the Australian continent have dominantly exploited surface wave tomography for the mantle, with seismic refraction, receiver functions, and ambient noise used for crustal structure. The 3-D structure has been

Seismic Hazard Analysis of Dam Siyaho in South Khorasan province (Eastern Iran) M Baghbani, E Gholami, HRR Barani, I Birjand - Journal of Tethys: Vol Abstract The identification of natural hazard prone areas for future planning requires an efficient decision support tool to provide the appropriate weights for the various topographical, geological, and seismological factors responsible for the expected hazards.

Oceanographic Signatures and Pressure Monitoring of Seafloor Vertical Deformation in Near-coastal, Shallow Water Areas: A Case Study from Santorini Caldera G Vilaseca, C Deplus, J Escartín, V Ballu, P Nomikou… - Marine Geodesy, 2016 ABSTRACT Bottom pressure, tilt, and seawater physical properties were monitored for a year using two instruments within the immerged Santorini caldera (Greece). Piggybacked on the CALDERA2012 cruise, this geodetic experiment was designed to monitor evolution of

Subduction of a buoyant plateau at the Manila Trench: Tomographic evidence and geodynamic implications J Fan, D Zhao, D Dong - Geochemistry, Geophysics, Geosystems, 2016 Abstract We determined P-wave tomographic images by inverting a large umber of arrival-time data from 2749 local earthquakes and 1462 teleseismic events, which are used to depict the three-dimensional morphology of the subducted Eurasian Plate along the

Focal mechanisms and stress variations in the Caucasus and northeast Turkey from constraints of regional waveforms TL Tseng, HC Hsu, PR Jian, BS Huang, JC Hu… - Tectonophysics, 2016 Abstract The continental collision between Arabia and Eurasia created large strike-slip faults in Turkey as well as mountains in the Caucasus and the volcanic plateau between them. In this study, we use regional waveforms of a new seismic array deployed between 2008 and

Mantle plumes beneath the South Pacific superswell revealed by finite frequency P tomography using regional seafloor and island data M Obayashi, J Yoshimitsu, H Sugioka, A Ito, T Isse… - Geophysical Research …, 2016 Abstract We present a new tomographic image beneath the South Pacific superswell, using finite frequency P wave travel time tomography with global and regional data. The regional stations include broadband ocean-bottom seismograph stations. The tomographic image

Transcurrent reactivation of Australia's western passive margin: An example of intraplate deformation from the central Indo-Australian plate JV Hengesh, BB Whitney - Tectonics, 2016 Abstract Australia's northwestern passive margin intersects the eastern termination of the Java trench segment of the Sunda arc subduction zone and the western termination of Timor trough along the Banda arc tectonic collision zone. Differential relative motion between the

Maximum Magnitude (Mmax) in the Central and Eastern United States for the 2014 US Geological Survey Hazard Model RL Wheeler - Bulletin of the Seismological Society of America, 2016
Abstract Probabilistic seismic-hazard assessment (PSHA) requires an estimate of M max, the moment magnitude M of the largest earthquake that could occur within a specified area. Sparse seismicity hinders M max estimation in the central and eastern United States (CEUS)

Data-Driven Seismic-Hazard Models Prepared for a Seismic Risk Assessment in the Dead Sea Region M Haas, A Agnon, D Bindi, S Parolai, M Pittore - Bulletin of the Seismological …, 2016
Abstract We derive a probabilistic seismic-hazard model for the Dead Sea region to allow for seismic risk estimation, which will be part of a subsequent study. This hazard model relies as much as possible on data-driven approaches, utilizing a seismic catalog compiled

First level seismic microzonation map of Al-Madinah province, western Saudi Arabia using the geographic information system approach S Sayed, R Moustafa, NS Al-arifi, MK Jafri, M Naeem… - Environmental Earth …, 2016 Abstract The identification of natural hazard prone areas for future planning requires an efficient decision support tool to provide the appropriate weights for the various topographical, geological, and seismological factors responsible for the expected hazards.

Were the May 2012 Emilia-Romagna earthquakes induced? A coupled flow-geomechanics modeling assessment R Juanes, B Jha, BH Hager, JH Shaw, A Plesch… - Geophysical Research …, 2016 Abstract Seismicity induced by fluid injection and withdrawal has emerged as a central element of the scientific discussion around subsurface technologies that tap into water and energy resources. Here we present the application of coupled flow-geomechanics

Imminent earthquake forecasting on the basis of Japan INTERMAGNET stations, NEIC, NOAA and Tide code data analysis SC Mavrodiev - arXiv preprint arXiv:1602.00152, 2016
Abstract: This research presents one possible way for imminent prediction of earthquake magnitude, depth and epicenter coordinates by solving the inverse problem using a data acquisition network system for monitoring, archiving and complex analysis of geophysical

Nepal earthquake 25 April 2015: source parameters, precursory pattern and hazard assessment R Prakash, RK Singh, HN Srivastava - Geomatics, Natural Hazards and Risk, 2016 ABSTRACT Spatio-temporal variations of seismicity within 300 km of the main Nepal earthquake of 25 April 2015 showed seismic quiescence since 2007. Decadal changes in b-value using the Gutenberg–Richter relation showed a well-marked decrease during the

The feeder system of the Toba supervolcano from the slab to the shallow reservoir I Koulakov, E Kasatkina, NM Shapiro, C Jaupart… - Nature communications, 2016 The Toba Caldera has been the site of several large explosive eruptions in the recent geological past, including the world's largest Pleistocene eruption 74,000 years ago. The major cause of this particular behaviour may be the subduction of the fluid-rich Investigator

Ground-motion prediction equations for shallow crustal and upper-mantle earthquakes in Japan using site class and simple geometric attenuation functions JX Zhao, S Zhou, J Zhou, C Zhao, H Zhang, Y Zhang… - Bulletin of the …, 2016 Abstract In this article, ground-motion prediction equations (GMPEs) based on the horizontal components of the strong-motion records from shallow crustal and upper-mantle earthquakes in Japan are presented. We assembled a large dataset from earthquakes with

The Zagan earthquake of February 1, 2011, in the low-seismoactive zone of western Transbaikalia: Observations and analysis
VI Melnikova, AI Seredkina, YB Radziminovich… - Seismic Instruments, 2016 Abstract—We described the February 1, 2011 (Mw= 4.7) Zagan earthquake occurred in the area of the Zagan range. This event is one of the most significant in western Transbaikalia. Macroseismic effects of this seismic event were felt over a wide territory: the intensity of II

Teleseismic depth estimation of the 2015 Gorkha□ Nepal aftershocks J Letort, L Bollinger, H Lyon-Caen, A Guilhem, Y Cano… - Geophysical Journal …, 2016 Abstract The depth of 61 aftershocks of the 2015 April 25 Gorkha, Nepal earthquake, that occurred within the first 20 d following the main shock, is constrained using time delays between teleseismic P phases and depth phases (pP and sP). The detection and

Source model of the 16 September 2015 Illapel, Chile, Mw 8.4 earthquake based on teleseismic and tsunami data M Heidarzadeh, S Murotani, K Satake, T Ishibe… - Geophysical Research …, 2016 Abstract We proposed a source model for the 16 September 2015 Illapel (Chile) tsunamigenic earthquake using teleseismic and tsunami data. The 2015 epicenter was at the northernmost of the aftershocks zone of the 2010 M w 8.8 Maule earthquake.

A Bayesian source model for the 2004 great Sumatra-Andaman earthquake Q Bletery, A Sladen, J Jiang, M Simons - Journal of Geophysical Research: Solid …, 2016 Abstract The 2004 M w 9.1–9.3 Sumatra-Andaman earthquake is one of the largest earthquakes of the modern instrumental era. Despite considerable efforts to analyze this event, the different available observations have proven difficult to reconcile in a single finite-

Investigating the role of source mechanism, surface topography, and attenuation on the observed PGA pattern in May 28, 2004, Mw 6.2 Baladeh earthquake (Iran) E Karkooti, ZH Shomali, M Pakzad - Journal of Seismology, 2016 Abstract In this paper, we use seismic waveform simulation to investigate the influence of source mechanism complexity, surface topography, and quality factor on the observed peak ground motions in May 28, 2004, moment magnitude (Mw) 6.2 Baladeh earthquake. The

Downgoing plate topography stopped rupture in the AD 2005 Sumatra earthquake TJ Henstock, LC McNeill, JM Bull, BJ Cook, SPS Gulick… - Geology, 2016 Abstract Earthquakes in subduction zones rupture the plate boundary fault in discrete segments. One factor that may control this segmentation is topography on the downgoing plate, although it is controversial whether this is by weakening or strengthening of the fault.

Kinematic analysis and palaeoseismology of the Edremit Fault Zone: evidence for past earthquakes in the southern branch of the North Anatolian Fault Zone, Biga … H Sözbilir, Ö Sümer, Ç Özkaymak, B Uzel, T Güler… - Geodinamica Acta, 2016 The Edremit Fault Zone (EFZ) forms one of the southern segments of the North Anatolian Fault Zone (NAFZ) at the northern margin of the Edremit Gulf (Biga Peninsula, South Marmara Region, Turkey). Stratigraphic, structural and kinematic results indicate that

Towards global seismic monitoring of underground nuclear explosions using waveform cross correlation. Part I: Grand master events DI Bobrov, IO Kitov, MV Rozhkov, P Friberg - Seismic Instruments, 2016 Abstract We propose to use waveform cross correlation techniques for seismic monitoring of the Comprehensive Nuclear-Test-Ban Treaty (CTBT) by proving the ability to build the Global Grid (GG) of master events using high-quality waveform templates at stations of the

Updated Tsunami Catalog for the Jalisco-Colima Coast, Mexico, Using Data from Historical Archives R Castillo-Aja, MT Ramírez-Herrera - Seismological Research Letters, 2016 ABSTRACT Modern earthquakes and tsunamis catalogs available online are compilations of earlier catalogs that included some inaccurate information. Here, we present a thorough revision of tsunamigenic earthquakes that, in historical time, have affected the Mexican

The 2015 Mw 7.1 earthquake on the Charlie-Gibbs transform fault: Repeating earthquakes and multimodal slip on a slow oceanic transform K Aderhold, RE Abercrombie - Geophysical Research Letters, 2016 Abstract The 2015 M w 7.1 earthquake on the Charlie-Gibbs transform fault along the Mid-Atlantic Ridge is the latest in a series of seven large earthquakes since 1923. We propose that these earthquakes form a pair of quasi-repeating sequences with the largest

DigitSeis: A New Digitization Software for Analog Seismograms
P Bogiatzis, M Ishii - Seismological Research Letters, 2016 ABSTRACT This article presents a new MATLAB software,

DigitSeis, that converts digital, raster images of analog seismograms to readily usable, digital time series using image-processing techniques. It classifies important features of analog seismograms, such as time

The M w 8.1 2014 Iquique, Chile, seismic sequence: a tale of foreshocks and aftershocks S Cesca, F Grigoli, S Heimann, T Dahm… - Geophysical Journal …, 2016 Abstract The 2014 April 1, M w 8.1 Iquique (Chile) earthquake struck in the Northern Chile seismic gap. With a rupture length of less than 200 km, it left unbroken large segments of the former gap. Early studies were able to model the main rupture features but results are

Investigation of the Izmit Earthquake with Interferometric SAR (InSAR), Global Navigation Satellite System (GNSS) Positioning and Coulomb Stress Modelling RA Barut, J Trinder, C Rizos
Summary: In 1999, the Izmit Earthquake struck Istanbul and its surroundings in northwest Turkey. It was one of the most devastating earthquakes of the twentieth century, significantly impacting on 20 million inhabitants and nearly half of the country's industry. The

SEISMIC DETECTION OF A LOW-VELOCITY ANOMALY UNDER THE STAGNANT SLAB BENEATH THE EASTERN NORTH CHINA CRATON WITH THE P-WAVE … CUI Hui-Hui, Z Yuan-Ze, SHI Yao-Lin, W Xiao-Ran… - Chinese Journal of …, 2016 Abstract We study the P-wave structure around the 660 km discontinuity (660) beneath the eastern North China Craton (NCC), using a deep earthquake occurred at the border of northeast China and Russia and recorded by the China Digital Seismograph Network

Seismicity and focal mechanisms of earthquakes in Egypt from 2004 to 2011 M Abdelazim, A Samir, IA El-Nader, A Badawy… - NRIAG Journal of …, 2016 Abstract The earthquake activity and the state of stress in and around Egypt will provide an opportunity to evaluate the seismic hazard. The seismicity data were compiled from the Egyptian National Seismological Network database during the period from 2004 to 2011 in

Core Concept: Tectonic tremors could offer insights into the big shakers D Venton - Proceedings of the National Academy of Sciences, 2016 Early in 1995, an earthquake struck Japan measuring 7.3 on the Richter scale (1). The shaking lasted for 20 seconds. Asphalt roads looked like shattered peanut brittle and whole neighborhoods crumpled to the ground. Nearly 6,400 people lost their lives, and more than

ANALYSING POST-SEISMIC DEFORMATION OF IZMIT EARTHQUAKE WITH INSAR, GNSS AND COULOMB STRESS MODELLING. RA Barut, J Trinder, C Rizos - … Archives of the Photogrammetry, Remote Sensing & …, 2016 ABSTRACT: On August 17th 1999, a Mw 7.4 earthquake struck the city of Izmit in the north-west of Turkey. This event was one of the most devastating earthquakes of the twentieth century. The epicentre of the Izmit earthquake was on the North Anatolian Fault (NAF) which
Ground-motion prediction equations for subduction slab earthquakes in Japan using site class and simple geometric attenuation functions JX Zhao, F Jiang, P Shi, H Xing, H Huang, R Hou… - Bulletin of the …, 2016 Abstract The frequency content of strong ground motions from subduction slab earthquakes differs significantly from that of ground motions produced by other categories (tectonic locations: shallow crustal, upper mantle, and subduction interface) of earthquakes in

An evaluation of earthquake hazard parameters in the Iranian Plateau based on the Gumbel III distribution H Mohammadi, Y Bayrak - Journal of Seismology, 2016 Abstract The Gumbel's third asymptotic distribution (GIII) of the extreme value method is employed to evaluate the earthquake hazard parameters in the Iranian Plateau. This research quantifies spatial mapping of earthquake hazard parameters like annual and 100-

Uppermost mantle P wavespeed structure beneath eastern China and its surroundings W Sun, BLN Kennett - Tectonophysics, 2016 Abstract Pn travel-time tomography provides a way of improving structural information on the uppermost mantle across eastern China exploiting recent developments of dense seismic networks with well recorded seismic events. We used waveforms from 2009 at Chinese

OF ROMANIA AND BLACK SEA AREA IA Moldovan, M Diaconescu, E Popescu, M Radulian… - Rom. Journ. Phys, 2016
In this study we have used the most reliable and homogeneous seismic datasets at the European scale, covering historical and modern instrumental seismicity until present days for the Eastern part of Romania and the Black Sea Area for computing the statistical

The First World Catalog of Earthquake-Rotated Objects (EROs), Part I: Outline, General Observations, and Outlook L Cucci, A Tertulliani, AM Lombardi - Bulletin of the Seismological Society of …, 2016 Abstract We present the first world catalog of earthquake-rotated objects (EROs). The catalog is composed of 2053 EROs originating during 184 earthquakes that occurred between 1349 and 2014. The catalog is organized into two tables that contain information

KivuSNet: The First Dense Broadband Seismic Network for the Kivu Rift Region (Western Branch of East African Rift) A Oth, J Barrière, N d'Oreye, G Mavonga, J Subira… - Seismological Research …, 2016 ABSTRACT The Kivu rift is located in the bordering region of the Democratic Republic of Congo and Rwanda, in the western branch of the East African rift. Here, the active olcanoes Nyamulagira (the most active in Africa) and Nyiragongo (host to the largest persistent lava

Crustal strain partitioning and the associated earthquake hazard in the eastern Sunda-Banda Arc A Koulali, S Susilo, S McClusky, I Meilano… - Geophysical Research …, 2016 Abstract We use Global Positioning System (GPS) measurements of surface deformation to show that the convergence between the Australian Plate and Sunda Block in eastern Indonesia is partitioned between the megathrust and a continuous zone of back-arc
Observations of seismicity and ground motion in the Northeast US Atlantic Margin from ocean-bottom seismometer data CH Flores, S Uri, JJ McGuire, JA Collins - Seismological Research Letters, 2016

ABSTRACT Earthquake data from two short-period ocean-bottom seismometer (OBS) networks deployed for over a year on the continental slope off New York and southern New England were used to evaluate seismicity and ground motions along the continental margin.

New data about small-magnitude earthquakes of the ultraslow-spreading Gakkel Ridge, Arctic Ocean AN Morozov, NV Vaganova, EV Ivanova… - Journal of Geodynamics, 2016 Abstract At the present time there is available detailed bathymetry, gravimetric, magnetometer, petrological, and seismic (mb> 4) data for the Gakkel Ridge. However, so far not enough information has been obtained on the distribution of small-magnitude

In and Around the Hazara-Kashmir Syntaxis: a Seismotectonic and Seismic Hazard perspective H Sana, SK Nath - J. Ind. Geophys. Union (september 2016), 2016 AbSTRACT this study presents the seismotectonics of the Hazara-Kashmir syntaxis and the surroundings. the detailed description of the origin, geology and structures of the Hazara-Kashmir syntaxis is presented. the structural alignment of the Hazara-Kashmir syntaxis is

The Hellenic Seismological Network of Crete (HSNC): validation and results of the 2013 aftershock sequences G Chatzopoulos, I Papadopoulos, F Vallianatos - Advances in Geosciences, 2016 Abstract The last century, the global urbanization has leaded the majority of population to move into big, metropolitan areas. Small areas on the Earth's surface are being built with tall buildings in areas close to seismogenic zones. Such an area of great importance is the

Evidence for anomalous mantle upwelling beneath the Arabian Platform from travel time tomography inversion I Koulakov, E Burov, S Cloetingh, S El Khrepy, N Al-Arifi… - Tectonophysics, 2016 Abstract We present a new model of P-velocity anomalies in the upper mantle beneath the Arabian Peninsula, Red Sea, and surrounding regions. This model was computed with the use of travel time data from the global catalogue of the International Seismological Center

Pre-Seismic Assessing Hazard: Examples of Northern Algeria S Aourari, D Bouziane, D Machane - Journal of Seismology and Earthquake …, 2016 Abstract The study aims to describe the potential seismic tectonic structures and the seismic hazard mapping. The pre-seismic assessing is initiated for two regions belonging to Algerian Maghrebides chain, Constantine area in the East and Relizane area in the West. It

Passive seismic experiment and receiver functions analysis to determine crustal structure at the contact of the northern Dinarides and southwestern Pannonian Basin F Šumanovac, E Hegedüs, J Oreškovi, S Kolar… - Geophysical journal …, 2016 Abstract Passive seismic experiment was carried out at the SW contact of the Dinarides and Pannonian basin to determine the crustal structure and velocity discontinuities. The aim of the experiment was to define the relationship between the Adriatic microplate and

A historical review of induced earthquakes in Texas C Frohlich, H DeShon, B Stump, C Hayward… - Seismological Research …, 2016 ABSTRACT In Texas, earthquakes have occurred in close ssociation with activities accompanying petroleum production since 1925. Here we develop a five-question test to categorize individual events as "tectonic,""possibly induced,""probably induced," or "almost

Modeling of Kashmir Aftershock Decay Based on Static Coulomb Stress Changes and Laboratory-Derived Rate-and-State Dependent Friction Law F Javed, S Hainzl, A Aoudia, M Qaisar - Pure & Applied Geophysics, 2016 Abstract We model the spatial and temporal evolution of October 8, 2005 Kashmir earthquake's aftershock activity using the rate-and-state dependent friction model incorporating uncertainties in computed coseismic stress perturbations. We estimated the

Site-specific probabilistic seismic hazard map of Himachal Pradesh, India. Part II. Hazard estimation P Muthuganeisan, STG Raghukanth - Acta Geophysica, 2016 Abstract This article presents site-specific probable seismic hazard of the Himachal Pradesh province, situated in a seismically active region of northwest Himalaya, using the ground motion relations presented in a companion article. Seismic recurrence parameters for all the

Application of the rule extraction method to evaluate seismicity of Iran M Khalili, A Zamani - Geopersia, 2016 Abstract Assessing seismic hazards involves specifying the likelihood, magnitude and location of earthquakes in a region. Predicting the seismic hazards is the first step in reducing the impact of the damage caused by an earthquake. In this study, to fully utilize all

THE TROBRIAND ISLANDS EARTHQUAKE AND TSUNAMI, 6 MARCH 1895. H Letz, K McCue, I Ripper - Science of Tsunami Hazards, 2016 Abstract An earthquake and tsunami struck the Trobriand Islands in March 1895 causing at least 30 deaths but until now the location and magnitude of the earthquake were quite uncertain. We have searched British and German colonial literature of the time to refine both

A study of earthquakes along the Mid-Atlantic Ridge between Charlie-Gibbs and the Azores HB Harðarson This thesis gives a seismicity overview of the Mid-Atlantic Ridge between the Charlie-Gibbs Fracture Zone and the Azores during the period of 1955-2015. The fault plane solutions on the ridge mostly show normal faulting which is to be expected on a spreading ridge. A few

Deep structure of the South Kara sedimentary basin AG Rodnikov, LP Zabarinskaya, VB Piip… - Russian Journal of Pacific …, 2016 Abstract The structure and evolution of the passive continental margins of the Arctic Ocean are considered on the example of the South Kara Basin. Its development is associated with the evolution of the West Siberian Plate and the formation of the Arctic Ocean. Until the Late

The 2016 Mw 6.7 Imphal Earthquake in the Indo-Burman Range: A Case of Continuing Intraplate Deformation within the Subducted Slab RM Parameswaran, K Rajendran - Bulletin of the

Seismological Society of America, 2016 Abstract The 2016 M w 6.7 Imphal earthquake is one of the largest and instrumentally well-recorded seismic events to have occurred on the segment of the Indo-Burman plate boundary, where Indian and Burman plates converge in a roughly northeast direction (∼ 3–

Uppermost mantle structure beneath eastern China and its surroundings from Pn and Sn tomography W Sun, BLN Kennett - Geophysical Research Letters, 2016 Abstract The Pn and Sn residuals from regional events provide strong constraints on the structure and lithological characteristics of the uppermost mantle beneath eastern China and its surroundings. With the dense Chinese Digital Seismic Network in eastern China, Related articles All 3 versions Cite

Risk Assessment of Safety Analysis of Nuclear Power Plant Structures in the Earthquake Active Zones J Kralik Abstract: This paper gives the results of the risk-based safety analysis of the seismic resistance of the NPP (Nuclear Power Plants) in Slovakia. The probabilistic assessment of NPP safety analysis is presented. On the base of the geophysical and seismological

Comprehensive recovery of a weak aftershock sequence in the North Atlantic using waveform crosses correlation D Bobrov, I Kitov, M Rozhkov, G Turiomuruguendo - arXiv preprint arXiv: …, 2016 Abstract: We apply cross correlation between multichannel seismic waveforms as a technique for signal detection and automatic event building at the International Data Centre (IDC). This technique allows detecting signals with amplitudes by at least a factor of two

The Chelyabinsk Meteorite as a multiple source of acoustic and seismic waves IO Kitov, DI Bobrov, VM Ovchinnikov, MV Rozhkov - Doklady Earth Sciences, 2016 Abstract Shock waves and impact of the Chelyabinsk Meteorite fragments on the ground initiated various waves in the atmosphere and the earth. Three different sources of seismic and infrasound waves were found by arrival time and azimuth of seismic and infrasound

Real-time estimation of energy magnitude for EEW purposes
M Picozzi, P Brondi, D Bindi, D Di Giacomo, S Parolai… - 2016
Although the radiated seismic energy ES represents a small portion of the total energy budget involved in the earthquake rupture process, it is an important physical parameter linked to the dynamic characteristics and stress release during the an earthquake rupture.

SEISMOLOGICAL BULLETIN OF SYOWA STATION, ANTARCTICA, 2014 T MASUNAGA, M KANAO
Seismic observations at Syowa Station (69.0 S, 39.6 E), East Antarctica, began in 1959 using a short-period seismometer with a natural period of 1.0 s (Eto, 1962). In 1967, a long-period seismograph was installed, and phase readings of teleseismic

Overview of the New Zealand Strong Motion Database project and performance of ground motion models C Van Houtte, S Bannister, C Holden, S Bouguignon…ABSTRACT: This article summarises work that has been undertaken to compile the New Zealand Strong Motion Database, which is expected to be a significant source of information for researchers and practitioners alike. The database contains 272 earthquakes recorded in

Investigation of 1-D crustal velocity structure beneath Izmir Gulf and surroundings by using local earthquakes O Polat, Ç Özer - AIP Conference Proceedings, 2016 In this study; we examined one dimensional crustal velocity structure of Izmir gulf and surroundings. We used nearly one thousand high quality (A and B class) earthquake data which recorded by Disaster and Emergency Management Presidency (AFAD)[1], Bogazici

Earthquake ground motion simulation at Zoser pyramid using the stochastic method: A step toward the preservation of an ancient Egyptian heritage AE Khalil, HEA Hafiez, M Girgis, MA Taha - NRIAG Journal of Astronomy and …, 2016 Abstract Strong ground shaking during earthquakes can greatly affect the ancient monuments and subsequently demolish the human heritage. On October 12th 1992, a moderate earthquake (Ms= 5.8) shocked the greater Cairo area causing widespread

Earthquake hazard analysis for the different regions in and around A□rı E Bayrak, □ Yilmaz, Y Bayrak - AIP Conference Proceedings, 2016 We investigated earthquake hazard parameters for Eastern part of Turkey by determining the a and b parameters in a Gutenberg–Richter magnitude–frequency relationship. For this purpose, study area is divided into seven different source zones based on their tectonic and

Earthquake Distribution in Northeast India from 1961-2010
AA Abong, AM George, EA Awhuwhe Abstract: This study investigated earthquake distribution in Northeast India from 1961 to 2010 with body wave magnitude, Mb≥ 2.9. Measure of central tendencies and spread, bar chart, pie chart, scatter plot were the statistical tools used. The data were obtained from

Earthquake forecasting and its verification in northeast India int'l seismological ce...WK Mohanty, AK Mohapatra, AK Verma, KF Tiampo… - … , Natural Hazards and Risk, 2016 The aim of the present study is to analyze the occurrences of future earthquakes using forecasting techniques from past seismicity in northeast India (latitude 20° N–31° N and longitude 87° E–97° E). The present study applies two types of retrospective binary

Deformation and source parameters of the 2015 Mw 6.5 earthquake in Pishan, western China, from Sentinel-1A and ALOS-2 data Y Wen, C Xu, Y Liu, G Jiang - Remote sensing, 2016 Abstract: In this study, Interferometric Synthetic Aperture Radar (InSAR) was used to determine the seismogenic fault and slip distribution of the 3 July 2015 Pishan earthquake in the Tarim Basin, western China. We obtained a coseismic deformation map from the

Seismic sensor misorientation measurement using P-wave particle motion: an application to the NECsaids array X Wang, QF Chen, J Li, S Wei - Seismological Research Letters, 2016 ABSTRACT Seismic sensor orientation is one of the most critical parameters for modern three-component seismological observation. However, this

parameter is easily subject to error imposed by strong magnetic anomalies near the station or by human error in

Updated Probabilistic Seismic-Hazard Values for Egypt R Sawires, JA Peláez, RE Fat-Helbary, HA Ibrahim - Bulletin of the Seismological …, 2016 Abstract Seismic hazard in terms of mean peak ground acceleration (PGA) and spectral acceleration (SA) values has been computed for Egypt using both historical and instrumental earthquake data. For this purpose, an updated earthquake catalog, spanning

Source mechanism and parameters of the 19 October 2012 earthquake, northern Egyptian continental margin int'l seismological ce...A Hassoup, M Toni, MMF Shokry, AMA Helal… - Arabian Journal of …, 2016 Abstract The 19 October 2012 earthquake (ML= 5.1) occurred in the northern continental margin of Egypt within the Nile Cone at latitude 32.35 N and longitude 31.27 E. The quake was felt over a wide area in north Egypt and East Mediterranean countries, but no casualties

Estimation of earthquake hazard parameters from incomplete data files. Part III. Incorporation of uncertainty of earthquake-occurrence model A Kijko, A Smit, MA Sellevoll - Bulletin of the Seismological Society of America, 2016 Abstract Most probabilistic seismic-hazard analysis procedures require that at least three seismic source parameters be known, namely the mean seismic activity rate , the Gutenberg–Richter b-value, and the area-characteristic (seismogenic source) maximum

Analysis of the devastating Kashmir earthquake 2005 aftershocks K Rehman, SMT Qadri, A Ali, A Ali, S Ahmed - Arabian Journal of Geosciences, 2016 Abstract Along with most of the northern Pakistan and the Kashmir regions (Kashmir and eastern districts of Khyber Pakhtunkhwa), Muzaffarabad and Balakot were shaken by a predominantly disastrous earthquake of magnitude Mw 7.6 in 2005. The earthquake is

The 2009 earthquake, magnitude mb 4.8, in the Pantanal Wetlands, west-central Brazil FL Dias, M Assumpção, EM Facincani, GS Franca… - Anais da Academia …, 2016 ABSTRACT The main goal of this paper is to characterize the Coxim earthquake occurred in June 15 th, 2009 in the Pantanal Basin and to discuss the relationship between its faulting mechanism with the Transbrasiliano Lineament. The earthquake had maximum intensity

SANDWICH: A 2D Broadband Seismic Array in Central Tibet X Liang, X Tian, G Zhu, C Wu, Y Duan, W Li, B Zhou… - Seismological Research …, 2016 ABSTRACT The tectonic processes that formed the Tibetan plateau have been a significant topic in earth science, but images of the subducting Indian continental lithosphere (ICL) are still not clear enough to reveal detailed continental collision processes. Seismological

GPS constraints on interplate locking within the Makran subduction zone E Frohling, W Szeliga - Geophysical Supplements to the Monthly Notices of the …, 2016 Abstract The Makran subduction zone is one of the last convergent margins to be investigated using space-based geodesy. While there is a lack of historical and modern instrumentation in the region, a sparse sampling of

Detection of the Wenchuan aftershock sequence using waveform correlation with a composite regional network M Slinkard, S Heck, D Schaff, N Bonal, D Daily… - Bulletin of the …, 2016 Abstract Using template waveforms from aftershocks of the Wenchuan earthquake (12 May 2008, M s 7.9) listed in a global bulletin and continuous data from eight regional stations, we detected more than 6000 additional events in the mainshock source region from

Potential slab deformation and plunge prior to the Tohoku, Iquique and Maule earthquakes M Bouchon, D Marsan, V Durand, M Campillo… - Nature Geoscience, 2016 Megathrust earthquakes rupture hundreds of kilometres of the shallow plate interface in subduction zones, typically at depths of less than 50 km. Intense foreshock activity preceded the 2011 Mw 9 Tohoku-oki (Japan) and 2014 Mw 8.2 Iquique (Chile) megathrust

Mid-ocean-ridge seismicity reveals extreme types of ocean lithosphere V Schlindwein, F Schmid - Nature, 2016 Along ultraslow-spreading ridges, where oceanic tectonic plates drift very slowly apart, conductive cooling is thought to limit mantle melting 1 and melt production has been inferred to be highly discontinuous 2–4. Along such spreading centres, long ridge sections without

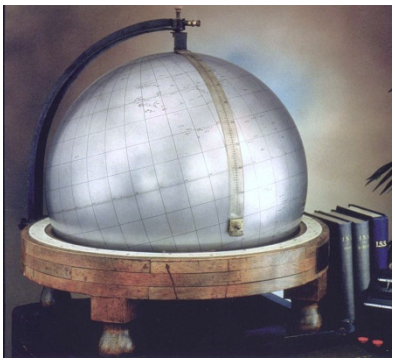
Fault interactions and triggering during the 10 January 2012 Mw 7.2 Sumatra earthquake W Fan, PM Shearer - Geophysical Research Letters, 2016 Abstract The 10 January 2012 M w 7.2 Sumatra earthquake in the Wharton basin occurred 3 months before the great M w 8.6 and M w 8.2 earthquakes in the same region, which had complex ruptures and are the largest strike-slip earthquakes

An improved geodetic source model for the 1999 M w 6.3 Chamoli earthquake, India W Xu, R Bürgmann, Z Li - Geophysical Supplements to the Monthly Notices of the …, 2016 Abstract We present a distributed slip model for the 1999 M w 6.3 Chamoli earthquake of north India using interferometric synthetic aperture radar (InSAR) data from both ascending and descending orbits and Bayesian estimation of confidence levels and trade-offs of the

The Engineering Strong-Motion Database: A Platform to Access Pan-European Accelerometric Data L Luzi, R Puglia, E Russo, M D'Amico, C Felicetta… - Seismological Research …, 2016 ABSTRACT This article describes the Engineering Strong-Motion Database (ESM), developed in the framework of the European project Network of European Research Infrastructures for Earthquake Risk Assessment and Mitigation (NERA, see Data and

Chile strong ground motion flatfile N Bastías, GA Montalva - Earthquake Spectra, 2016 The Nazca-South American plate boundary produces large-magnitude events (Mw> 8) every 20 years on the coast of Chile. This work describes a public ground motion database that contains 3,572 records from 477 earthquakes

SUMMARY OF ACHIEVEMENTS



- We gratefully acknowledge support from 63 Member-Institutions (3 new), development grants from CTBTO, USGS, US NSF, FM Global, Lighthill Risk Network, OYO, Aspen Re as well as sponsorship from Reftek and GeoSIG.
- We also thank UK Knowledge Transfer Programme for its financial contribution towards the joint project of building the Visual Bulletin Analysis System (VBAS) together with the OeRC, Oxford University.
- 17-19 staff members, 3 consultants and 2 members of Oxford University worked at the ISC improving and extending the ISC data and services.
- 1,698 stations have been registered and modified in the International Station Registry.
- Preliminary bulletin data are collected from 30 networks and data centres worldwide.
- Revised bulletins are collected from 139 networks worldwide.
- During 2016, ~47,000 events with ~5 million associated phases have been added to the Reviewed ISC Bulletin.
- The ISC-GEM catalogue has been extended to include known events with moment magnitudes above 5.5 during 1920-1934 and 2013.
- The ISC Event Bibliography reached ~18,700 articles related to ~15,100 seismic events.
- The new ISC-EHB dataset has been launched, first for data years 2000-2003, to gradually replace the existing EHB dataset widely used around the world.
- Other ISC development projects included:
    - The CTBTO Link to the ISC database;
    - The ISC Bulletin Rebuild;
    - The Visual Bulletin Analysis System
- We continued to maintain the IASPEI Reference (GT) Event List, the EHB Bulletin and the List of International Contacts in Seismology.
- The ISC database mirrors were operated at IRIS DMC in Seattle, ERI in Tokyo and LLNL in Livermore. A new ISC database mirror has been built by China Earthquake Administration to operate in Beijing and Xian.
- The ISC staff participated in a large number of meetings and conferences and received good publicity throughout the year.
- Several scientific articles describing new ISC products were submitted and/or published.
- The large number of scientific articles published worldwide in 2016 indicates a wide-ranging use of the ISC Bulletin data by many researchers.

Signed, July 18, 2016

Dr. Dmitry A. Storchak
Director