institute
of mine
seismology

TETRA TECH

Seismic Monitoring of Tailings Dams

Tjaart de Wit
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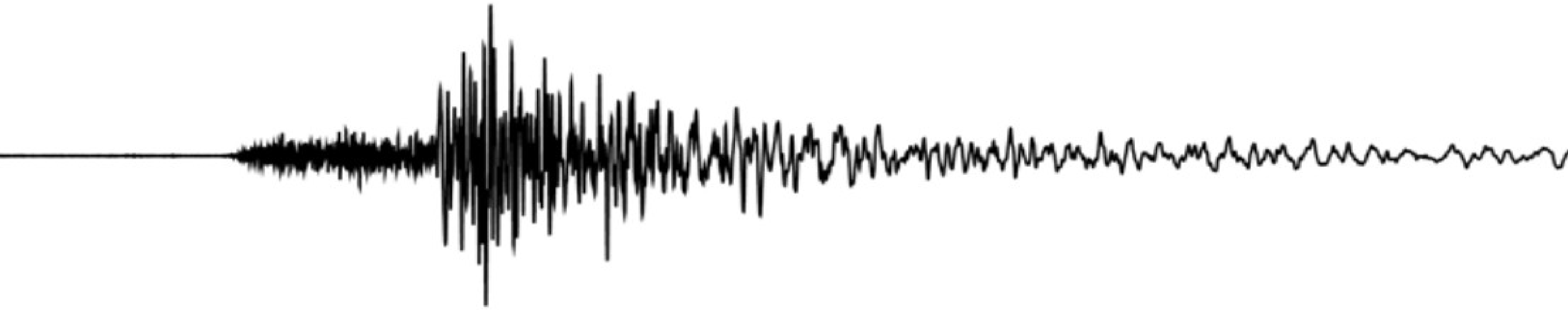


19 August 2021, II Workshop Técnico Tetra Tech – Microssísmica

Institute of Mine Seismology

IMS is the leading provider of microseismic monitoring technology to mines

260 operational systems in 38 countries

Stellenbosch, South Africa.

Hobart, Australia.

Sudbury, Canada.

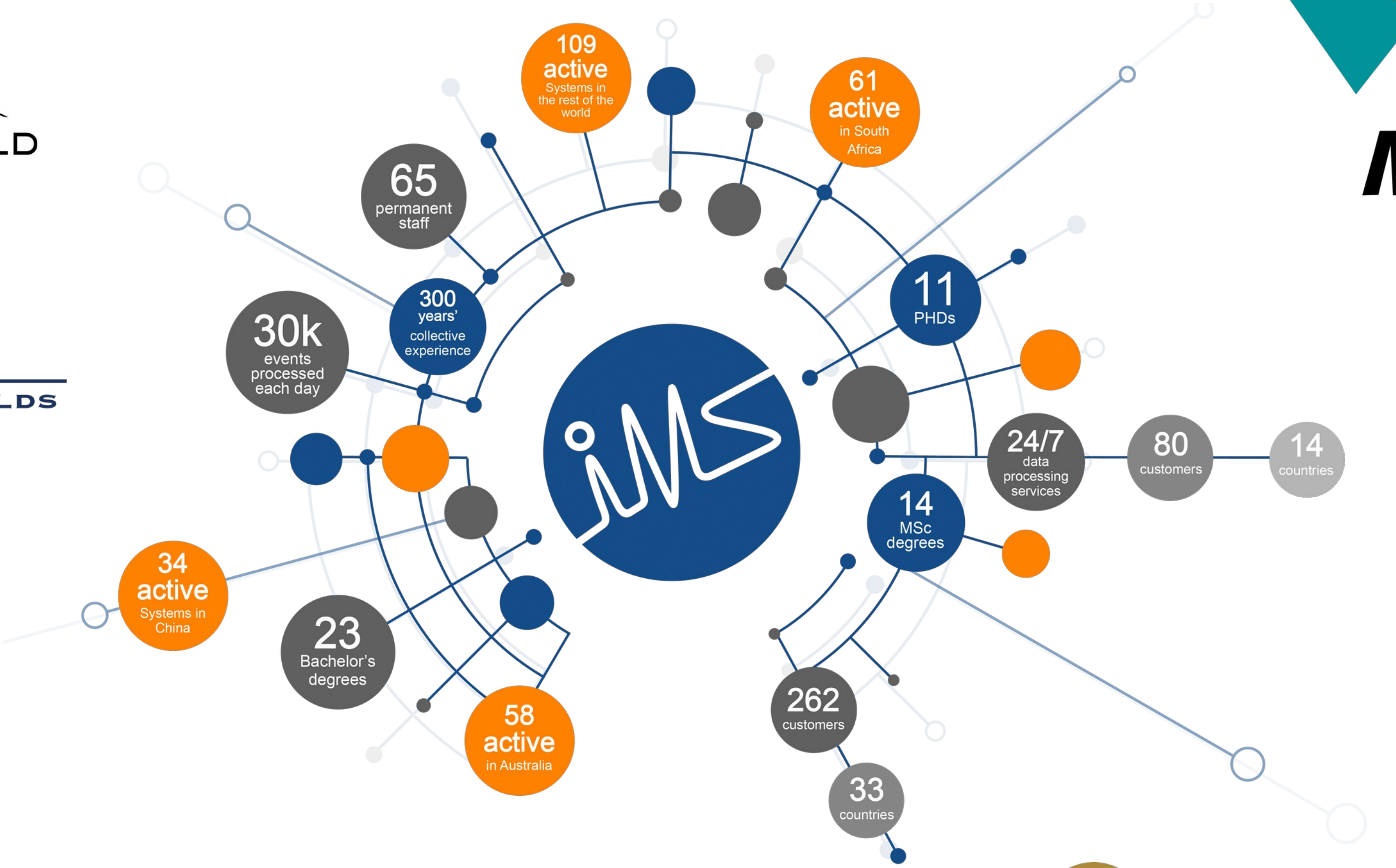
FREEPORT-MCMORAN

ANGLOGOLD ASHANTI

GOLD FIELDS

SOUTH32

NORTHERN STAR
RESOURCES LIMITED



109 active
Systems in the rest of the world

61 active
in South Africa

65
permanent staff

300 years'
collective experience

30k
events processed each day

11
PHDs

24/7
data processing services

80
customers

14
countries

14
MSc degrees

34 active
Systems in China

23
Bachelor's degrees

58 active
in Australia

262
customers

33
countries

VALE

Mosaic

CODELCO

MMG

NEWCREST
MINING LIMITED

bhpbilliton

RioTinto

LKAB

AngloAmerican

Seismology and Dams

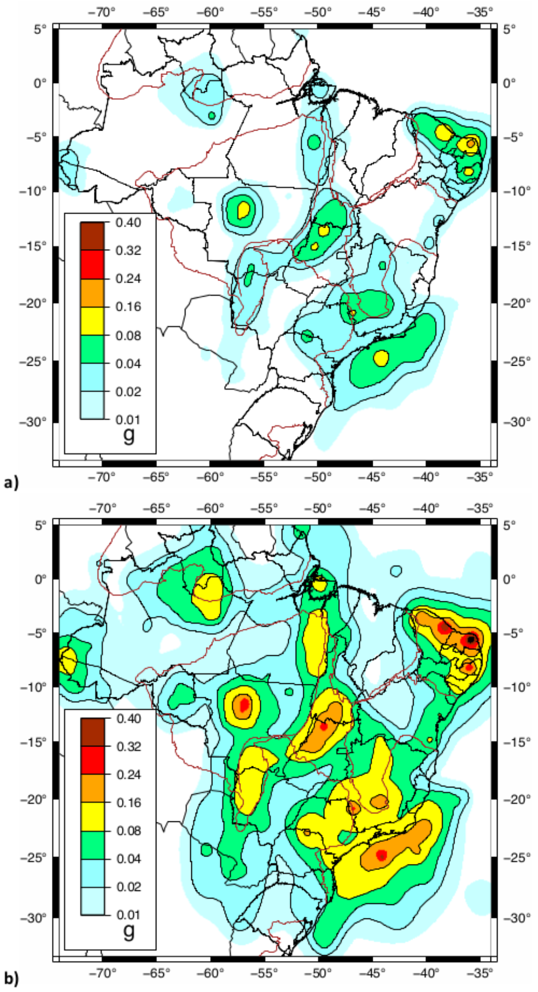
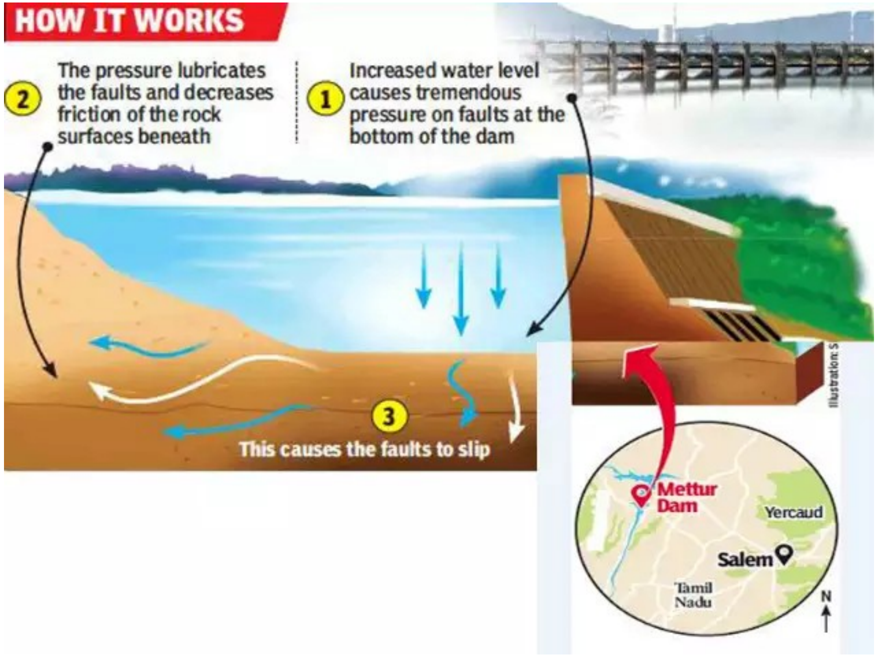


Fig. 7. Mapas de Ameaça Sísmica ("Seismic Hazard Maps") para aceleração de pico (PGA) em rocha, para probabilidades de 10% (**a**) e 2% (**b**) de excedência em 50 anos, correspondendo a períodos de retorno de 475 e 1475 anos, respectivamente. Cores são PGA em frações de g. Áreas verdes correspondem a PGA entre 4% e 8% g (equivalente a intensidades ~VI na escala Mercalli Modificada, podendo causar trincas em paredes), áreas amarelas entre 8% e 16% g (intensidades ~VII MM podendo causar rachaduras em paredes e desabamento de casas fracas).



Assumpção et. al., (2016)

Mw7.9 Sichuan earthquake

NEWS OF THE WEEK | SEISMOLOGY

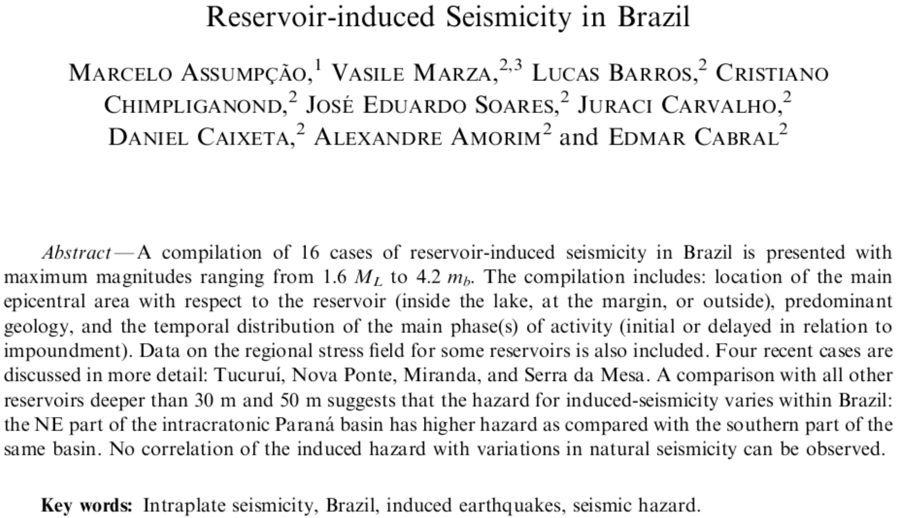
A Human Trigger for the Great Quake of Sichuan?

Richard A. Kerr, Richard Stone

+ See all authors and affiliations

Science 16 Jan 2009:
Vol. 323, Issue 5912, pp. 322
DOI: 10.1126/science.323.5912.322

Reservoir Induced Earthquakes

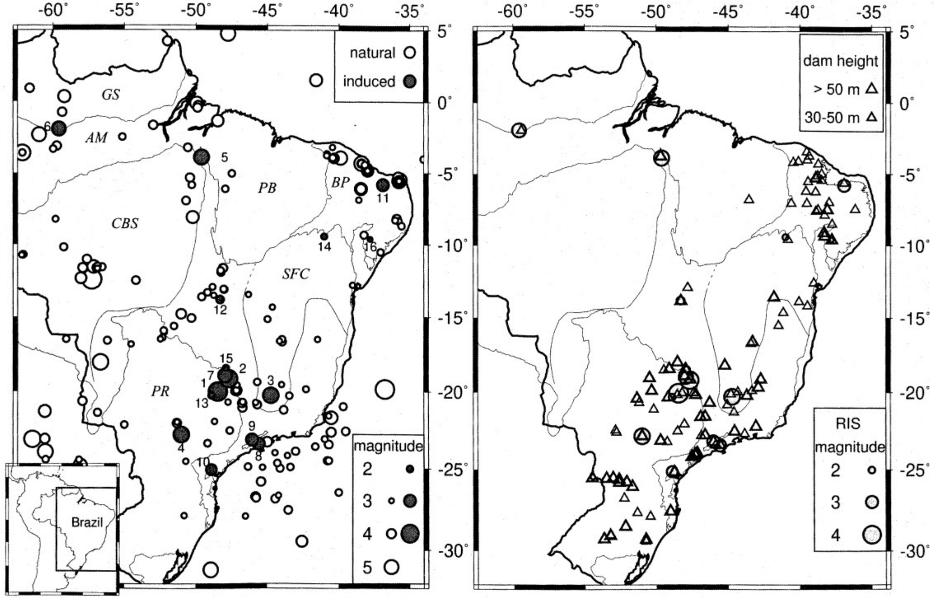


Reservoir-induced Seismicity in Brazil

Marcelo Assumpção,[1] Vasile Marza,[2,3] Lucas Barros,[2] Cristiano Chimpliganond,[2] José Eduardo Soares,[2] Juraci Carvalho,[2] Daniel Caixeta,[2] Alexandre Amorim[2] and Edmar Cabral[2]

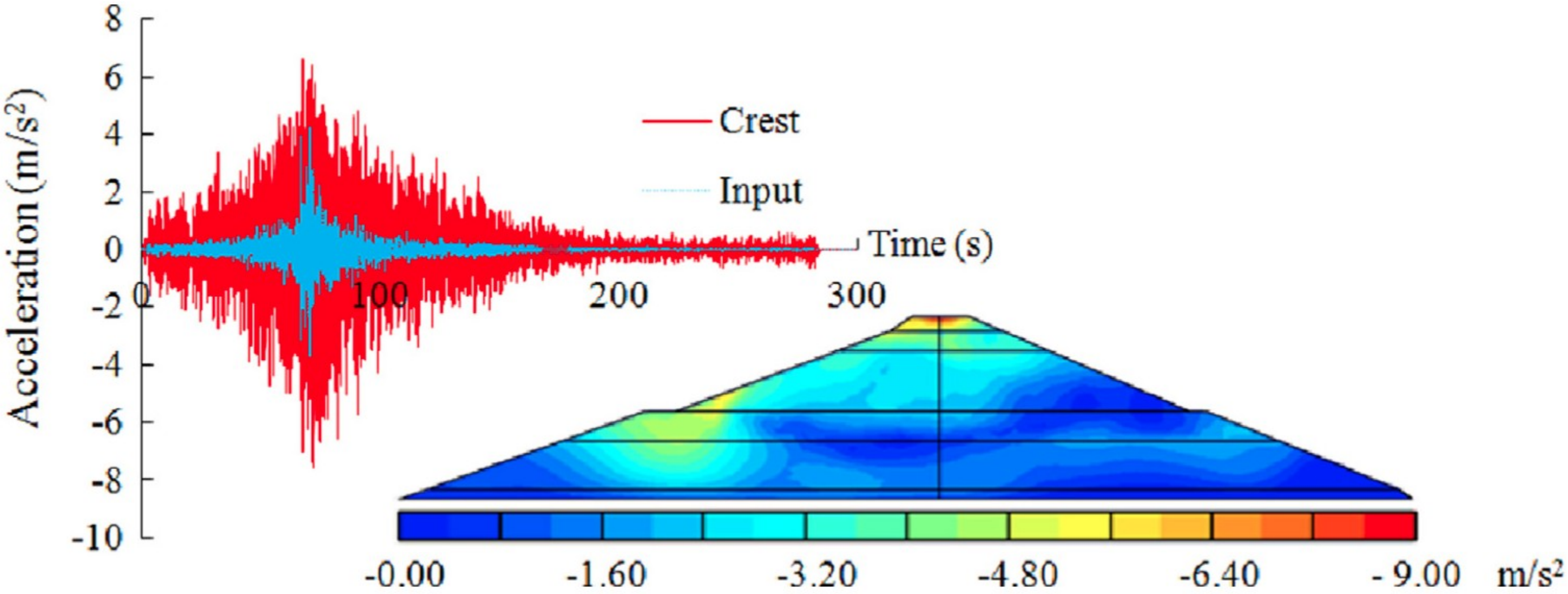
Abstract—A compilation of 16 cases of reservoir-induced seismicity in Brazil is presented with maximum magnitudes ranging from 1.6 M_L to 4.2 m_b. The compilation includes: location of the main epicentral area with respect to the reservoir (inside the lake, at the margin, or outside), predominant geology, and the temporal distribution of the main phase(s) of activity (initial or delayed in relation to impoundment). Data on the regional stress field for some reservoirs is also included. Four recent cases are discussed in more detail: Tucuruí, Nova Ponte, Miranda, and Serra da Mesa. A comparison with all other reservoirs deeper than 30 m and 50 m suggests that the hazard for induced-seismicity varies within Brazil: the NE part of the intracratonic Paraná basin has higher hazard as compared with the southern part of the same basin. No correlation of the induced hazard with variations in natural seismicity can be observed.

Key words: Intraplate seismicity, Brazil, induced earthquakes, seismic hazard.



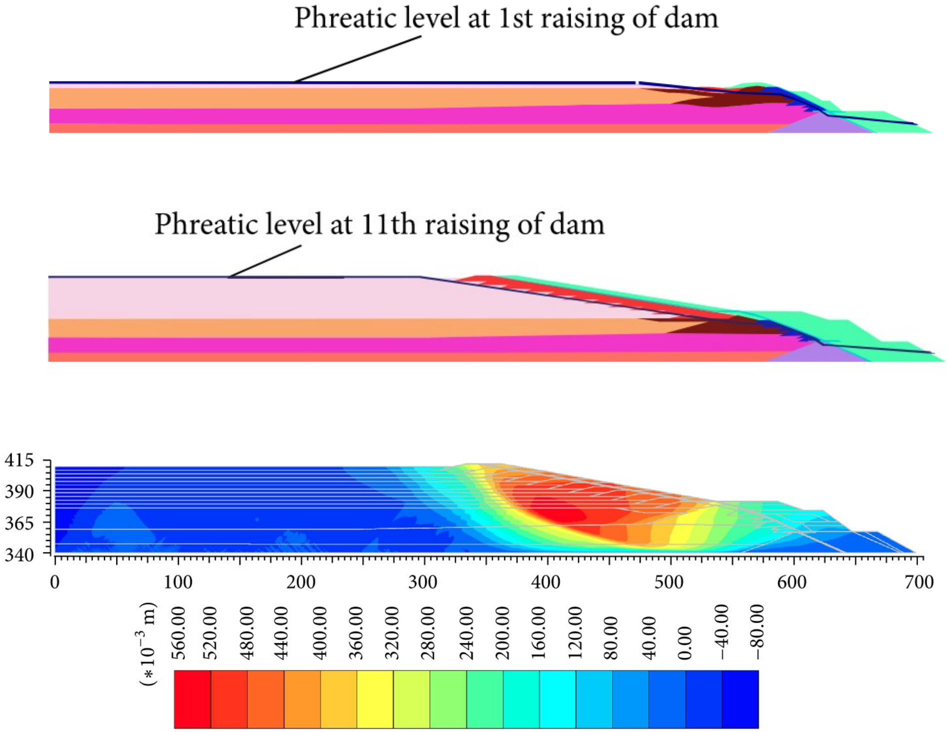
Assumpção et. al., (2002)

Why monitor vibrations on dams?

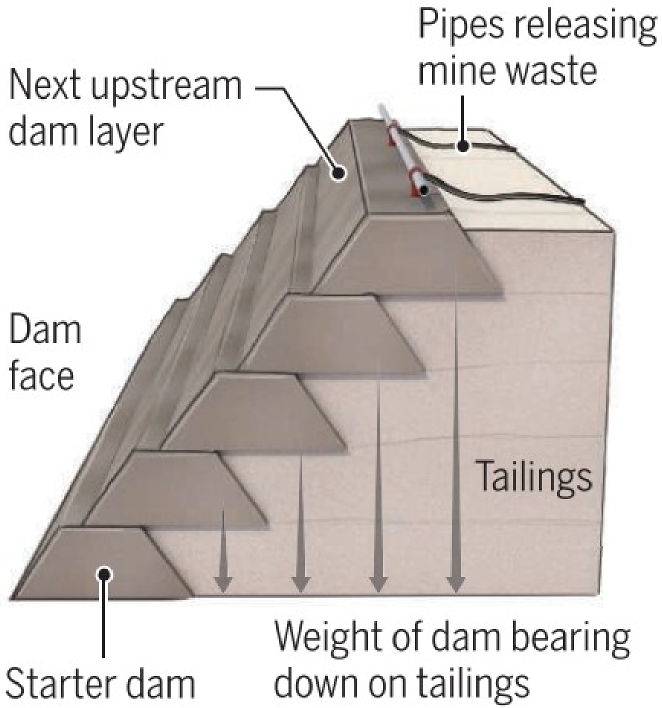


Charatpangoona et al., (2014)

Why monitor vibrations on tailings dams?



Zardari, (2017)

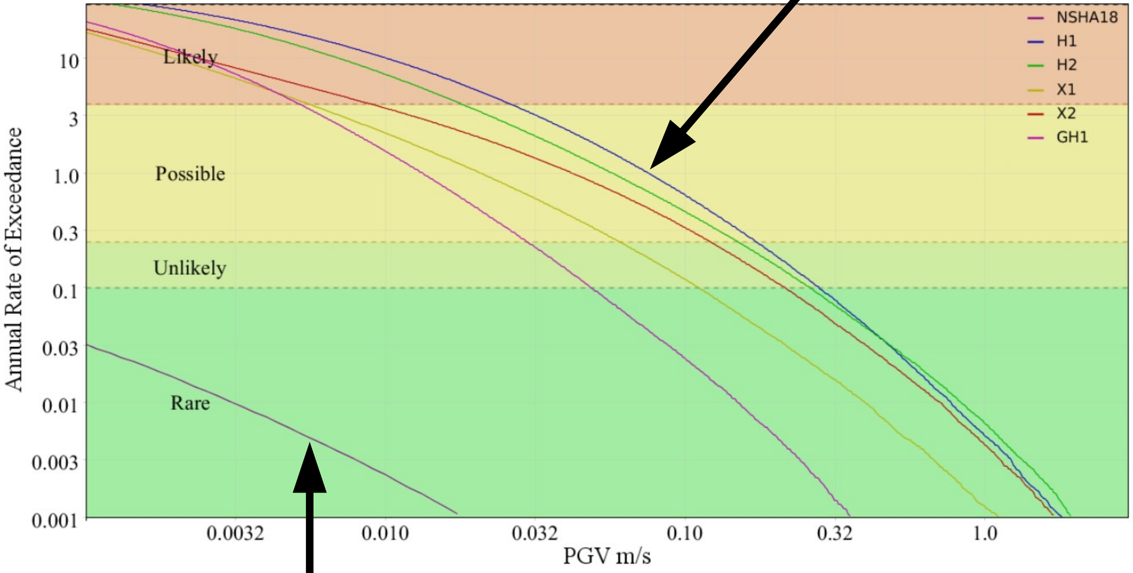


Warren, (2020)

Why monitor vibrations on tailings dams?

Why monitor vibrations on tailings dams?

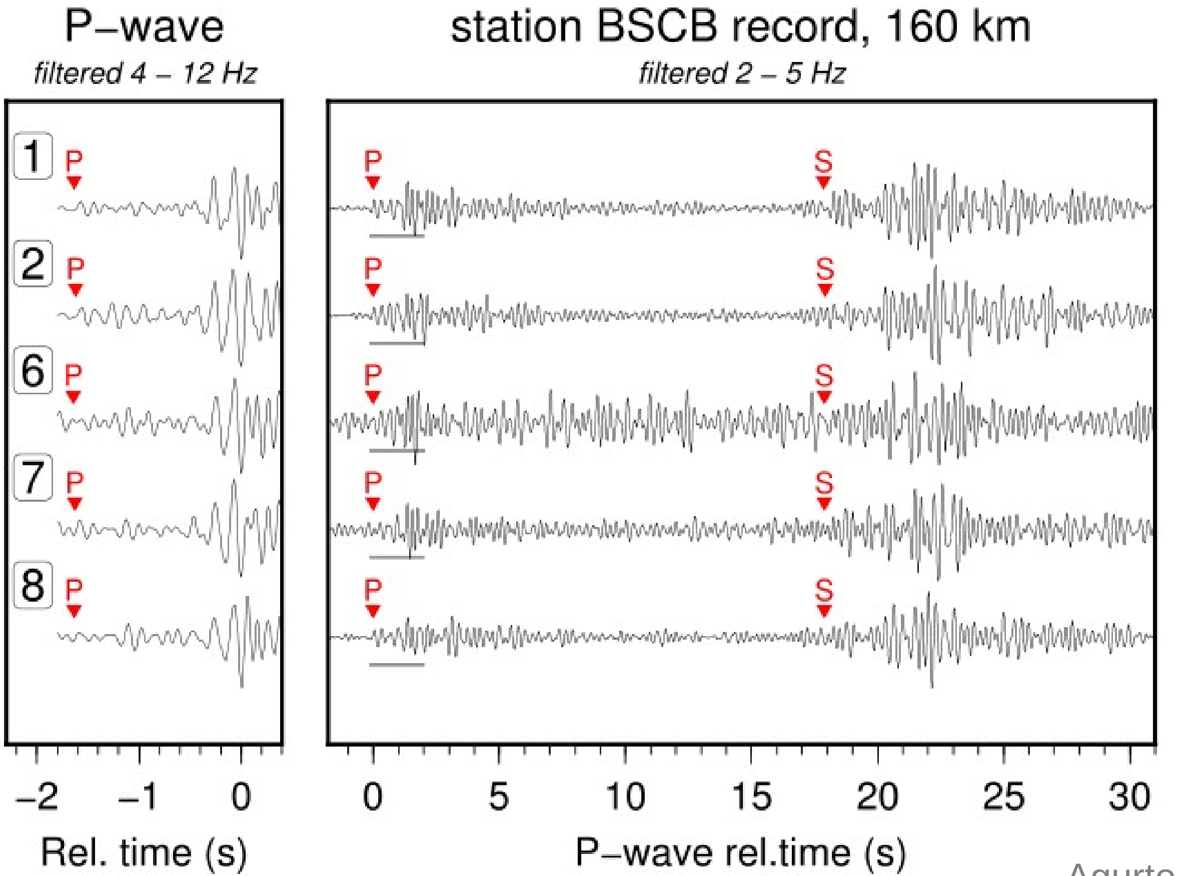
Ground Motion Hazard from Mining-Induced Seismic Activity



Ground Motion Hazard from Regional Seismic Activity

Birch, (2020)

Why monitor vibrations on tailings dams?



Agurto-Detzel et. al., (2016)

Why monitor vibrations on tailings dams?

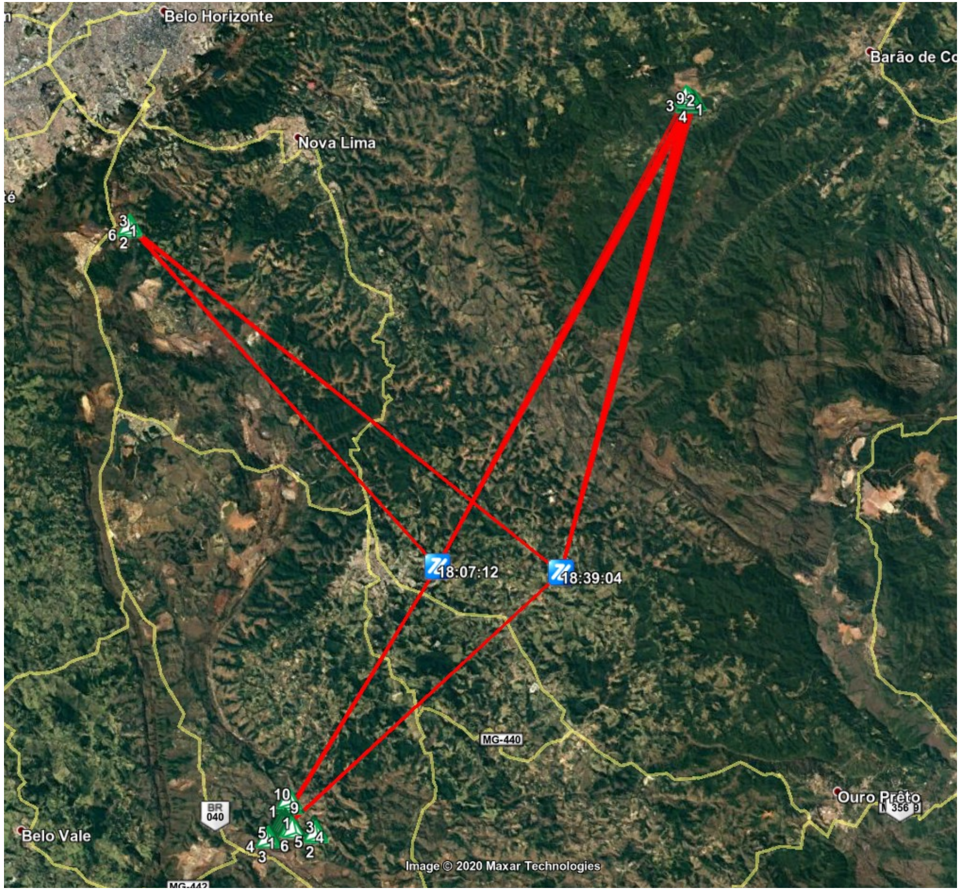
Regional Earthquakes

TREMORES EM ITABIRITO/MG

@sismousp
@sismologiabr

07-08-2020 às 00:53 - Mag 2.1
07-08-2020 às 18:39 - Mag 2.7

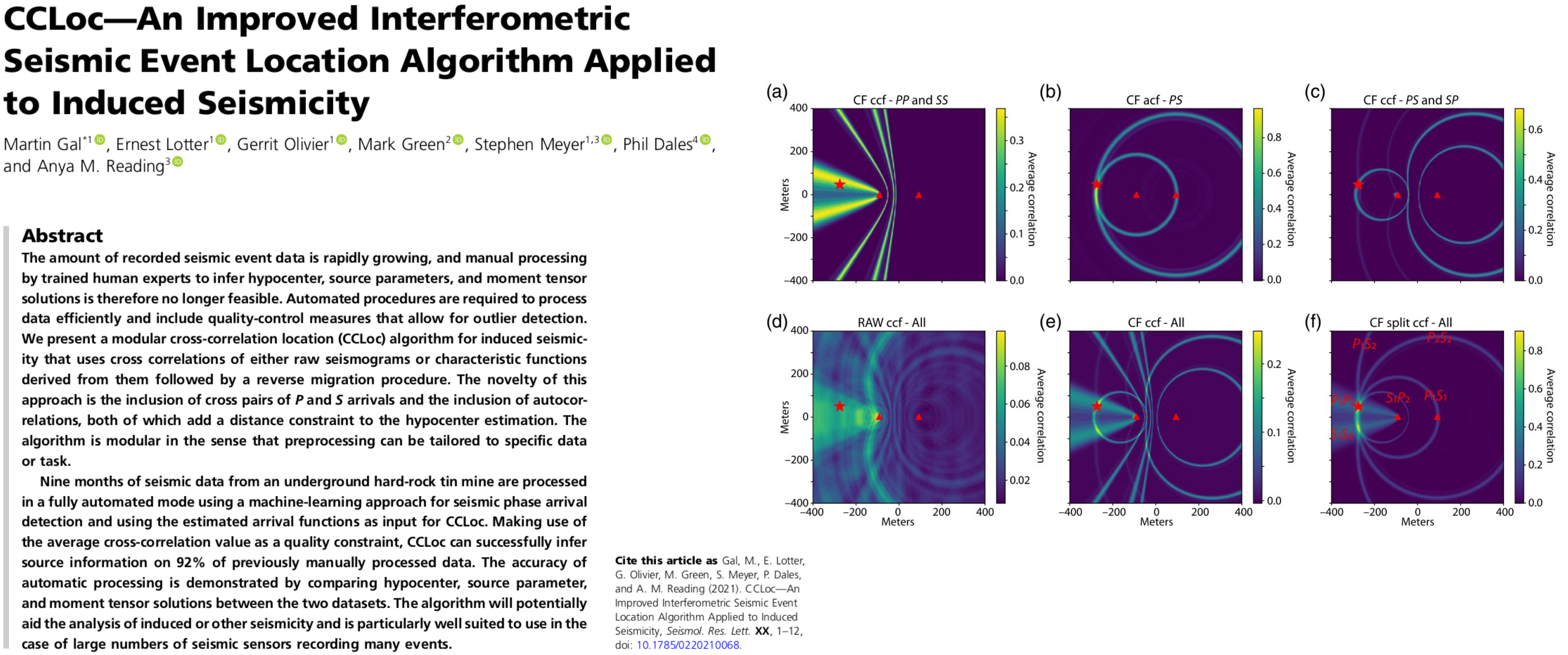
Regional Earthquakes



Monitoring equipment

Over to Gareth

Cross-correlation Location



CCLoc—An Improved Interferometric Seismic Event Location Algorithm Applied to Induced Seismicity

Martin Gal*[1], Ernest Lotter[1], Gerrit Olivier[1], Mark Green[2], Stephen Meyer[1,3], Phil Dales[4], and Anya M. Reading[3]

Abstract

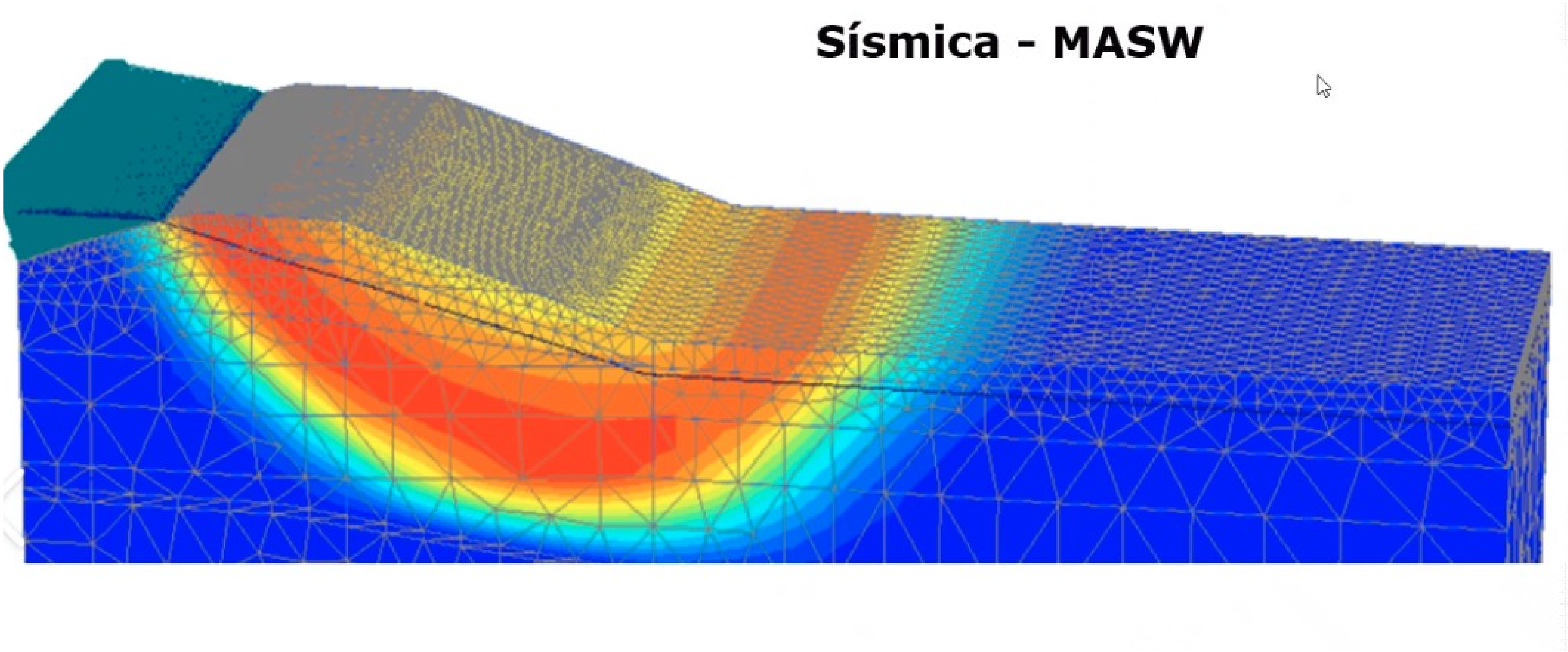
The amount of recorded seismic event data is rapidly growing, and manual processing by trained human experts to infer hypocenter, source parameters, and moment tensor solutions is therefore no longer feasible. Automated procedures are required to process data efficiently and include quality-control measures that allow for outlier detection. We present a modular cross-correlation location (CCLoc) algorithm for induced seismicity that uses cross correlations of either raw seismograms or characteristic functions derived from them followed by a reverse migration procedure. The novelty of this approach is the inclusion of cross pairs of *P* and *S* arrivals and the inclusion of autocorrelations, both of which add a distance constraint to the hypocenter estimation. The algorithm is modular in the sense that preprocessing can be tailored to specific data or task.

Nine months of seismic data from an underground hard-rock tin mine are processed in a fully automated mode using a machine-learning approach for seismic phase arrival detection and using the estimated arrival functions as input for CCLoc. Making use of the average cross-correlation value as a quality constraint, CCLoc can successfully infer source information on 92% of previously manually processed data. The accuracy of automatic processing is demonstrated by comparing hypocenter, source parameter, and moment tensor solutions between the two datasets. The algorithm will potentially aid the analysis of induced or other seismicity and is particularly well suited to use in the case of large numbers of seismic sensors recording many events.

Cite this article as Gal, M., E. Lotter, G. Olivier, M. Green, S. Meyer, P. Dales, and A. M. Reading (2021). CCLoc—An Improved Interferometric Seismic Event Location Algorithm Applied to Induced Seismicity, *Seismol. Res. Lett.* **XX**, 1–12, doi: 10.1785/0220210068.

Gal et. al., (2021)

Velocity Model



Braga, (2021)