Coordination of event type codes and their relation to Quakeml standards

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MOTIVATION

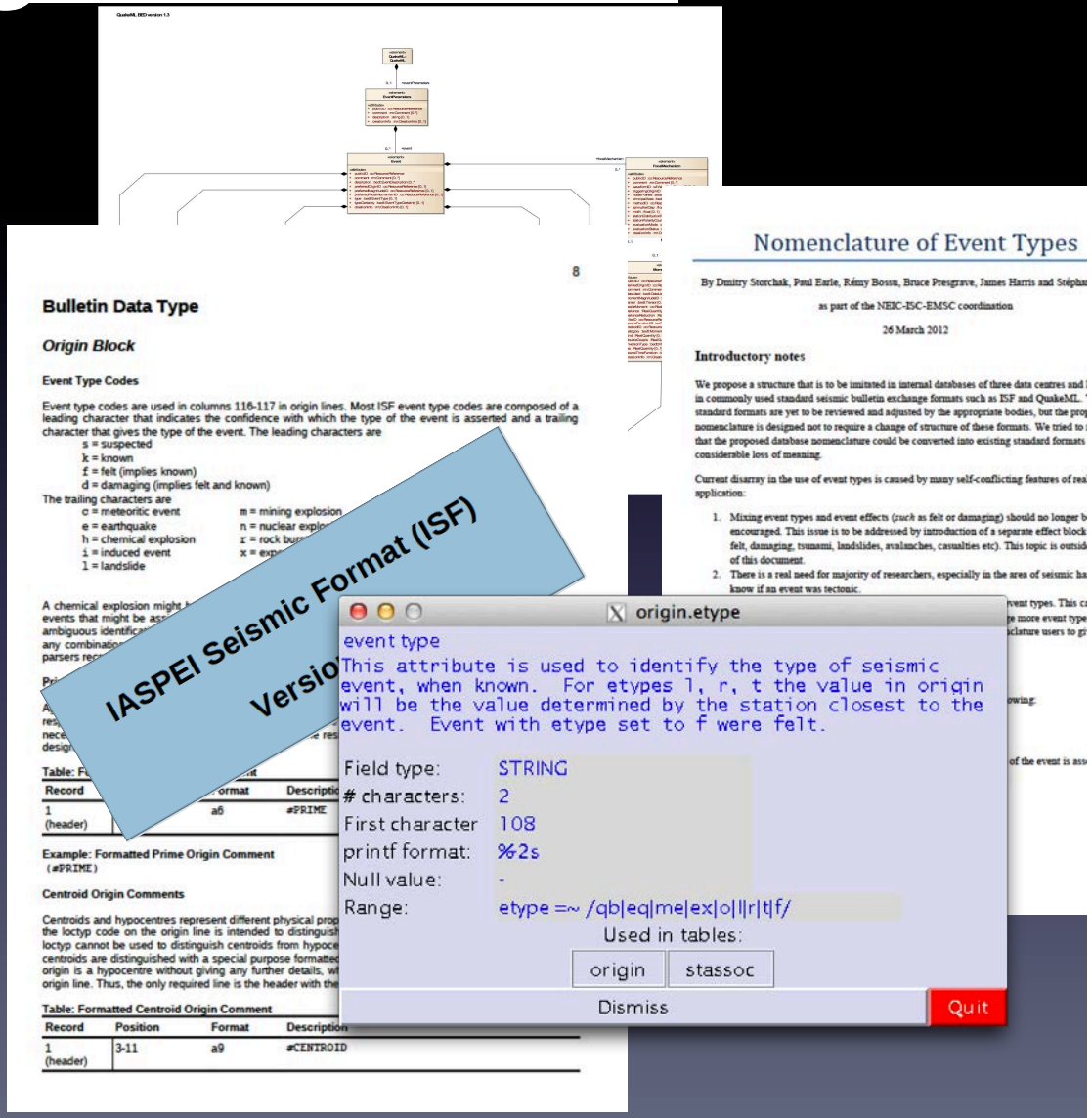
- Want a *standard* for event type designation. Not many internationally adopted standards exist!
- Many groups use their own legacy designations. Does this take us into the future?

COMPLICATION & DEPENDENCIES

- Catalogue use, css3.0 schema: 2 char
- Research use
- Data exchange with other organizations
- Web display

Existing 'Standards'

- Antelope usage
- IASPEI v2.0
- NEIC-ISC-EMSC
- QuakeMl v1.3
- Others?



Where we are with Antelope

- Not a standard in and of itself. However Antelope adopted a standard.
- Adopted standard: late 1980's css3.0 schema definition of event type.
- Used by CTBTO and various national data centres.
- Uses: *eq*, *qb*, *me*, *ex*.
- Later added L, B, R, T as default acceptable values at request of GSC (not a standard).

FDSN

- International Organization (Federation of Digital Seismograph Networks)
- Governing body for approval of QuakeMl standards.
- Used in FDSN web services.
- No use of event type codes, at this time.

IASPEI

- International Organization (**International Association of Seismology and Physics of the Earth's Interior**)
- Isf 2.0 (2016)
- 2 char codes
  - 1st char: indicates the confidence with which the type of the event is asserted.

    s = suspected

    k = known

    f = felt (implies known)

    d = damaging (implies felt and known)

IASPEI

- 2nd char: the type of the event.

  c = meteoritic event

  e = earthquake

  h = chemical explosion

  i = induced event

  l = landslide

  m = mining explosion

  n = nuclear explosion

  r = rock burst

  x = experimental explosion

NEIC-ISC-EMSC classification (2012 proposal)

- Three organizations (not a recognized seismological international governing body)
- Uses 2 char codes
  - Similar but not identical letter codes to IASPEI
- Event type classification
  - Not part of the QuakeML format, however there is a large amount of cross-over in event type terminology.
  - Uses inter-term hierarchies.

NEIC-ISC-EMSC classification 1st character

- The **first** (leading) character, the **certainty**, can be one of:

  s = suspected

  k = known

  u = unknown

  n = not reported

NEIC-ISC-EMSC classification
2nd character

u = null (to follow the first character being "u" or "n")

e = earthquake

a = anthropogenic event or event linked to an anthropogenic activity

- c = collapse (of underground cavity, mine or building) (see comments)
- x = explosion
  - f = accidental explosion
  - h = chemical explosion
  - g = controlled explosion
  - j = experimental explosion
  - d = industrial explosion
  - m = mining explosion (quarry blast, road cut, blasting cave)
  - n = nuclear explosion
- i = induced or triggered event
  - r = rock burst
  - w = reservoir loading
  - k = fluid injection
  - q = fluid extraction
- p = plane/train/boat crash

o = other

- s = atmospheric (sonic boom, sonic blast, acoustic noise, thunder)
- b = avalanche
- y = hydroacoustic event
- z = ice quake
- l = landslide (rockslide) (see comments)
- t = meteorite
- v = volcanic eruption

Heirarchal structure

QuakeML

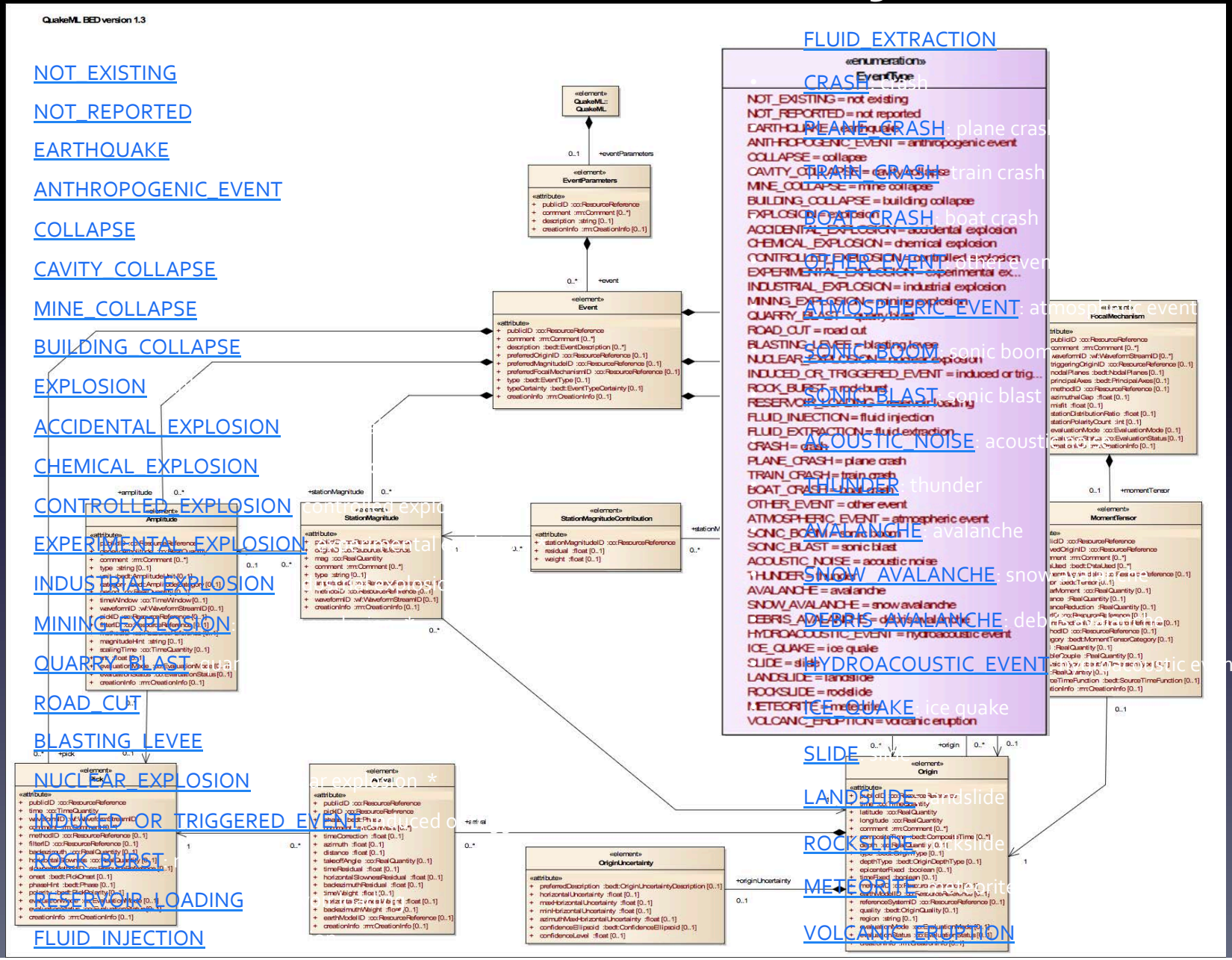
- Event classification system.
  - v1.2 – stable
  - v2.0 – next version, *not stable*
- Hosted by Swiss Seismological Service (ethz).
  - Team: Swiss SS, GeoForschungsZentrum Potsdam (GFZ), Gempa Potsdam, USGS, UW, Orpheus, EMSC, ISTI
- Flexible, extensible, and modular XML schema system of seismological event data.

What is XML?

- Extensible Markup Language
- Defines a set of rules for encoding documents in a format that is both *human readable* and *machine readable*.
- Emphasizes simplicity, generality, and usability across the internet.
- Language is widely used for representation of arbitrary data structures such as those used in web services.
- Many API's (application program interface) have been developed to aid in the processing of XML data.

QuakeML 2.0 – Event classifications

- NOT_EXISTING
- NOT_REPORTED
- EARTHQUAKE
- ANTHROPOGENIC_EVENT
- COLLAPSE
- CAVITY_COLLAPSE
- MINE_COLLAPSE
- BUILDING_COLLAPSE
- EXPLOSION
- ACCIDENTAL_EXPLOSION
- CHEMICAL_EXPLOSION
- CONTROLLED_EXPLOSION
- EXPERIMENTAL_EXPLOSION
- INDUSTRIAL_EXPLOSION
- MINING_EXPLOSION
- QUARRY_BLAST
- ROAD_CUT
- BLASTING_LEVEE
- NUCLEAR_EXPLOSION
- INDUCED_OR_TRIGGERED_EVENT
- ROCKBURST
- RESERVOIR_LOADING
- FLUID_INJECTION
- FLUID_EXTRACTION
- CRASH
- PLANE_CRASH
- TRAIN_CRASH
- BOAT_CRASH
- OTHER_EVENT
- ATMOSPHERIC_EVENT
- SONIC_BOOM
- SONIC_BLAST
- ACOUSTIC_NOISE
- THUNDER
- AVALANCHE
- SNOW_AVALANCHE
- DEBRIS_AVALANCHE
- HYDROACOUSTIC_EVENT
- ICE_QUAKE
- SLIDE
- LANDSLIDE
- ROCKSLIDE
- METEORITE
- VOLCANIC_ERUPTION



Quake ML

Future versions *may*:

- Next version (2.0) of QuakeML may adopt a SKOS (semantic web family of standards - *simple knowledge organization system*) representation on the EMSC-ISC-NEIC classification, but may reconsider the content.
- Give two fields to define event type.
  - No indication of what these may be.

Antelope Event Type Adoption Considerations

- StationXML & QuakeMl are changing the way the seismological community exchanges station data and event data. Is this the future path for data exchange?
- QuakeMl users: USGS, Orfeus, Swiss Seismological Network,….
- A lot of thought has gone into event types by a number of international organizations. It is not clear that there is a set of commonly agreed upon event type classification and event type codes within the seismological community at this time, although it appears to be converging. QuakeMl 2.0 may resolve this. Note the distinction between:
  a) event type classifications: e.g. *earthquake*, *mining explosion*, *ice quake*, *avalanche*, etc.
  b) event type code (2 char): e.g. known earthquake = *kx*

Practical Considerations

- Compatibility with QuakeMl or EMSC-ISC-NEIC would need to be mapped out and would include a number of assumptions.
- Adoption of 2 char proposed solution types leads to a large number of possible character classifications which would be annoying to select in a drop down list (combination of pulldown list and keyboard entry might be desirable).
- Reality is that a smaller subset would be primarily in use for each network, although this subset may differ from network to network depending on network's mandate/focus.
- Css3.0 *origin.review* field can be useful for additional network specific event information storage. E.g. Eastern Canada confirms blast events with mines and will mark the *origin.review* as *conf* for a mining event that's been confirmed with the mine operator. This has implications for hazard computations.

Conclusion

- Event type classifications:
  - QuakeMl 1.2 is the current FDSN accepted standard.
- Event type codes:
  - IASPEI 2 char codes (international org, may or may not be considered a seismological governing body)
    - Proposed 2 char are orthogonal representations of the data.
  - NEIC-ISC-EMSC 2 char codes with inter-event heirarchies (3 individual organizations)

Potential Path forward:

1. Use the current classification standard (QuakeMl 1.2) and code (IASPEI 2.0?) .
2. Expect to upgrade to QuakeMl 2.0 which may be a SKOS representation of NEIC-ISC-EMSC classifications, potentially with content changes, and possibly an adoption of 2 char codes at the same time.
3. Provide antelope users with a conversion script to upgrade to the new code standards.

Discussion/Next Steps?

- What is the direction of the community standards?
- Do we all wish to continue maintaining format transformation codes?
  - And how lossy are those content transformations?