Rescaled Range Analysis of Seismic Time Series

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R/S Analysis & R-code

- The **Rescaled Range Analysis (R/S)** represents a simple and robust method for determining the **Hurst exponent**, ***H***. Depending on *H* value, persistence or antipersistence can be set. [1-2]

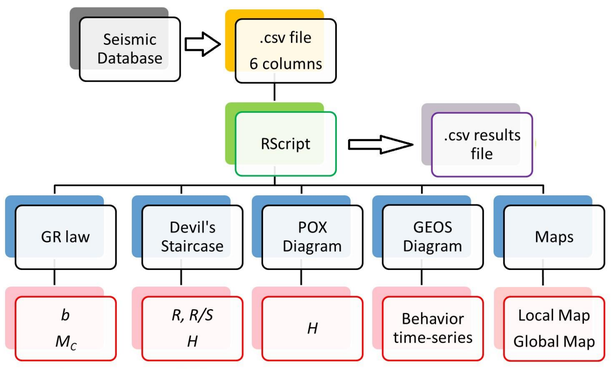
  Persistence: long-term memory effects. If the series has increased/decreased in the past, it is very likely that it will continue increasing/decreasing in the future. Persistent series are the most common in nature

  Antipersistence: if the series is increasing, it is likely that it will decrease in the future, and vice-versa

- A user friendly **R-code** has been created to calculate *H* by means of R/S analysis. It also provides graphics useful to expand the study of a seismic time series:
  - POX and GEOS **diagrams** and Evolution of *H* with time [2]
  - **Gutenberg-Richter Law** (GR) [3]

Goal: **Study of complex seismic series**
Study of persistency of seismic series

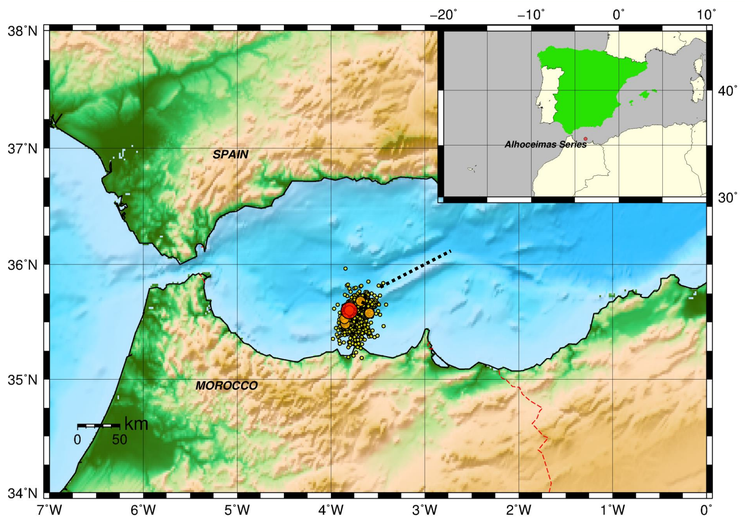
R-Code Scheme

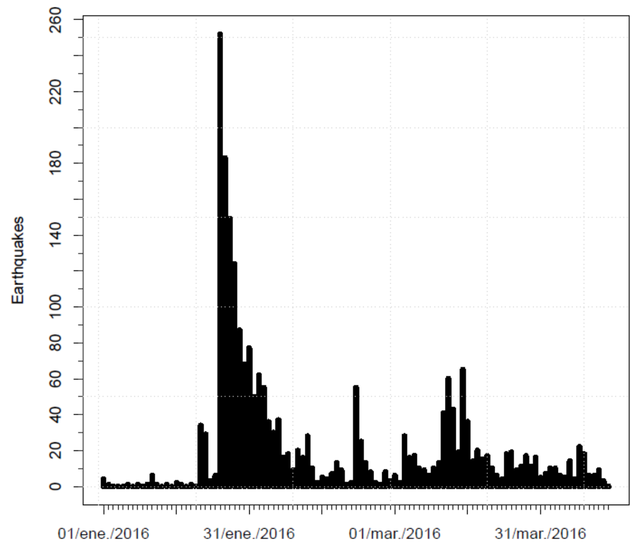


Data needed:

- Date and time
- Magnitude
- Location (latitude/longitude)

Melilla seismic series





15 / 01 / 2016 – 15 / 04 / 2016

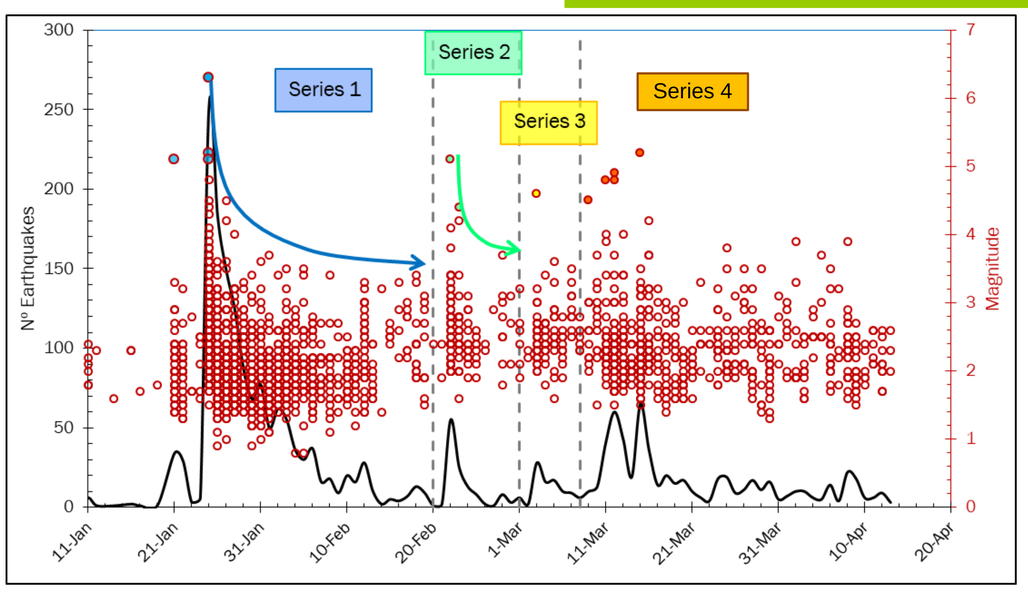
The events occurred in the **Alboran Basin**, a complex zone that is being squeezed between the **approaching Iberian and African Plates**. [4]

This convergence results in a westward shift of the Alboran block. **Current tectonics** is characterized by two families of conjugate **tear fault systems**. [5]

The southern zone of the Alboran Sea has had several important episodes of seismic activity since 1990, such as in **1994 (M5.7)** and in **2004 (M6.2)**

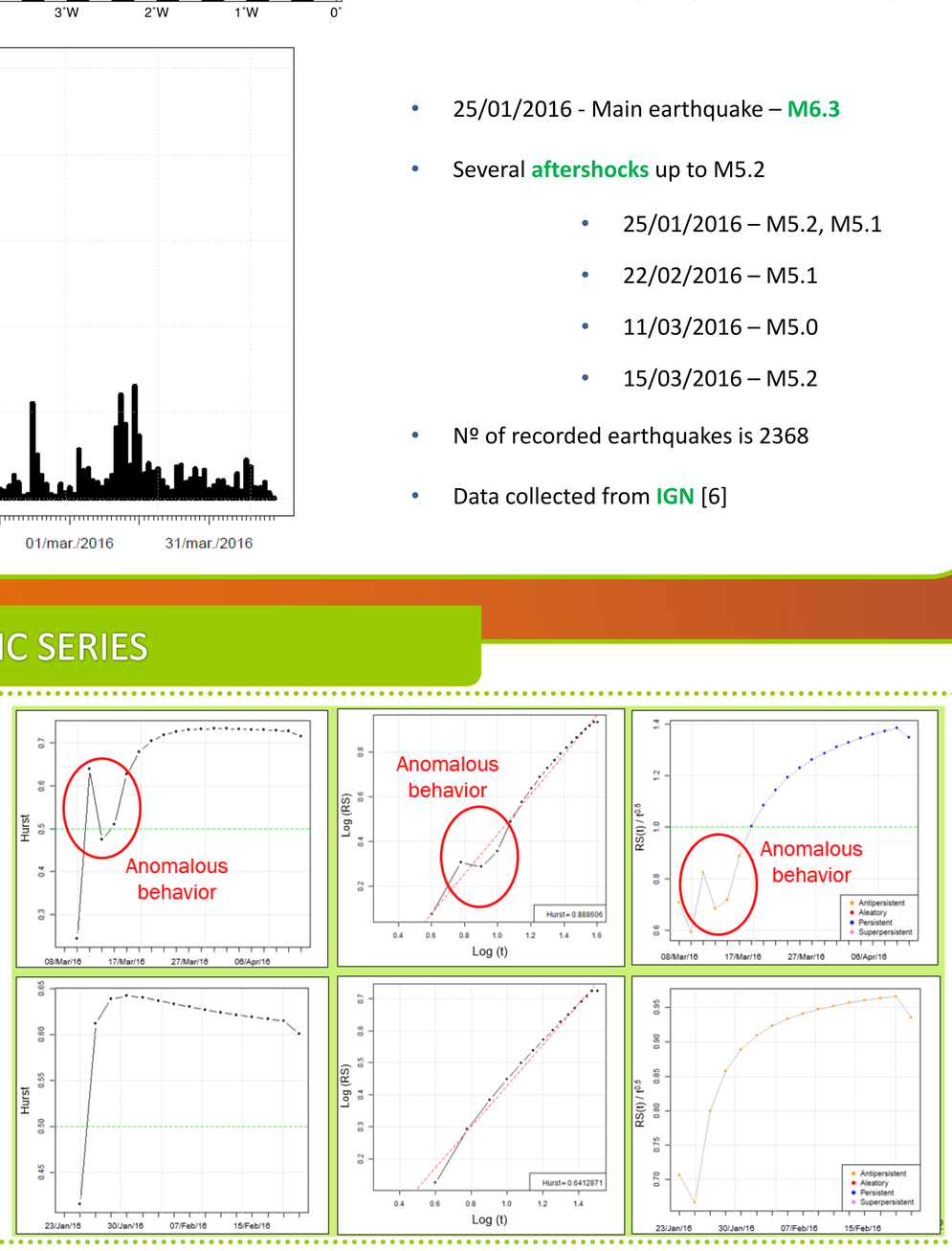
- 25/01/2016 - Main earthquake – **M6.3**
- Several **aftershocks** up to M5.2
  - 25/01/2016 – M5.2, M5.1
  - 22/02/2016 – M5.1
  - 11/03/2016 – M5.0
  - 15/03/2016 – M5.2
- Nº of recorded earthquakes is 2368
- Data collected from **IGN** [6]

R/S ANALYSIS OF MELILLA SEISMIC SERIES



Subdivision

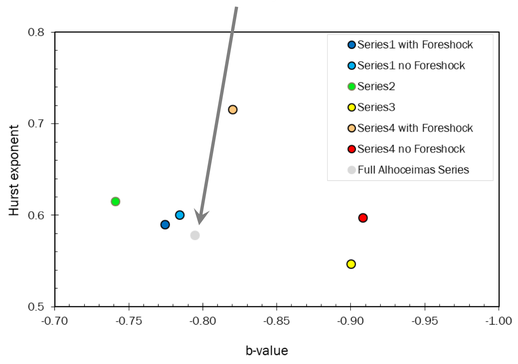
- Based on **Omori-Utsu Law** [7]
- Based on output diagrams from R-code:
  - *H* variation with time
  - **POX** diagram
  - **GEOS** diagram
- Based on Mogi's classification of earthquakes distribution [8]



Hurst exponent and b-value

Values obtained with R-code:

- Full Series: **H = 0.58** → **persistence**



- **Once** the full series has been **divided**, *H* and *b* are calculated again.
- Differences between those values come from the **characteristics of the source.** [9]

SubSeries

SERIES 1

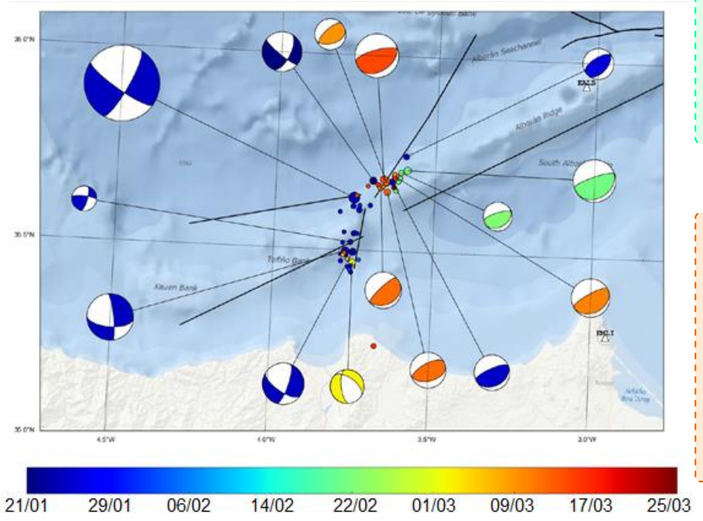
- 15/01/2016 – 19/02/2016
- Mogi type II: Foreshock (M5.1) + Mainshock (M6.3) + Afteshocks (M5.2, M5.1, M4.8, M4.5, M4.2)
- Strike-slip fault

SERIES 3

- 02/03/2016 – 08/03/2016
- Mogi type I: Mainshock (M4.6) + Afteshocks (M < 4)
- Normal dip-slip fault

Focal Mechanisms calculated by **IGN** [5]:

- For earthquakes M > 3
- Linked to each location
- Colored by time of occurrence



SERIES 2

- 20/02/2016 – 01/03/2016
- Mogi type I: Mainshock (M5.1) + Afteshocks (M4.4, M4.2)
- Reverse dip-slip fault

SERIES 4

- 09/03/2016 – 15/04/2016
- Mogi type III: swarm
- Reverse dip-slip fault

CONCLUSIONS

- R-code diagrams give the key to identify complex seismic series.
- Persistence study for **Melilla** seismic series **2016** carried out, obtaining **H=0.58 (persistent).**
- **Division** of complex seismic series in **agreement** with values obtained by other institution (**IGN**)

NEXT STEPS:

- Study more seismic series depending on the **source** (volcanic, tectonic, triggered).
- Study seismic evolution by means of R/S analysis with a time unit of 12 hours instead of 1 day.

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