# Status of the investigations in the frame of GG&S Contract between GEN and the Consortium

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Géosciences pour une Terre durable
brgm

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# BRGM
# The French Geological Survey
## (*a Public Institution*)

Géosciences pour une Terre durable
brgm

## Risks Division

Risks and Prevention Division

***Geological Hazards***

***Multi-hazards***

***Vulnerabilities***

***Risks***

***Multi-risks***

***Systemic analysis***

***Uncertainties***

***Geological knowledge through observations and modelling***

***Support to public policy development***

***Transfers to industry***

***Since 1965***

***1100 Employees***

**Activity (2011) M€ 108**

- Geology
- Mineral resources
- Geothermal energy
- Geological storage of $CO_2$
- Water
- Post-mining
- Risks
- Polluted soils and waste
- Metrology
- Information systems

# STATUS OF THE GG&S CONTRACT

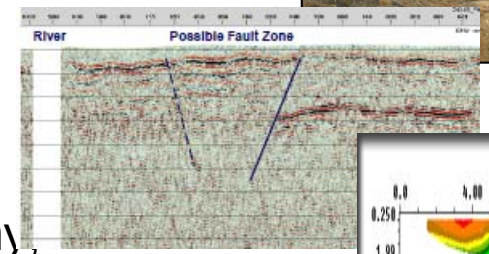
- GEN issued on January 2007 the technical specifications
- BRGM proposed services with the help of a Consortium comprising IRSN, GeoZs and ZAG
- The Contract has been signed on 26th of October, 2007.
- Later, the contract has been completed with two annexes signed in 2009 and in 2011
- Most part of the scientific works have been successfully completed on October 2010
- After new investigations on Libna fault, the Consortium has not found agreement on the consequences of findings
- After common agreement IRSN has left the Consortium on 31 January 2013
- The 3 other partners pursue the contract since the IRSN withdrawal

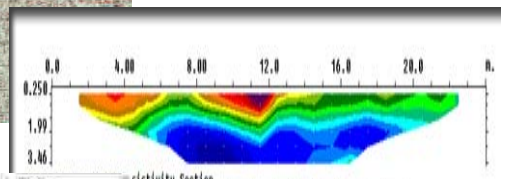
# Field and Experimental Investigations

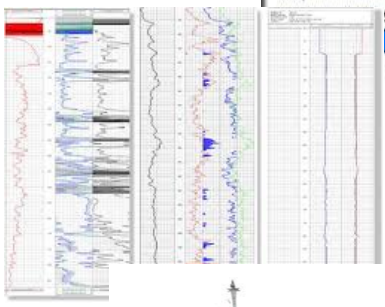
## Geological investigation

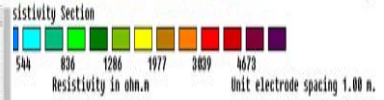
(Geodesy, Boreholes, Trenching, Dating, Structural mapping)


## Geophysical Survey (High resolution seismic reflection, Seismic downhole, Active and Passive MASW profile, Electrical resistivity Tomography, Geophysical logging)






## Seismological Investigation

(H/V, Accelerometer network)

## Geotechnical Investigation

(In-situ testing, Laboratory testing)

# Interpretation

**Geological** (Morphometric analyses, Revaluation of main data, Analysis of recent stress and strain fields, Surface faulting)

**Seismological** (Existing guidance in regulatory guide, Seismicity, Geological structures and seismic sources, Correlation of Earthquake activity with Seismic Source, Probabilistic seismic hazard motion, Deterministic analysis, Seismic wave transmission characteristics of the site, Sensitivity analysis, Numerical modelling and soils factors determinations (2D/3D)

**Geotechnical** (Review of existing data, Determination of ground deformation and damping, Interpretation of geophysical, In-situ and laboratory test, Liquefaction potential assessment, Geomechanical model, Assessment of input data for preliminary conceptual design, Preliminary numerical assessment on wall stability, Embankment compaction specification and construction condition)

# Consortium production

- **Reports:** **Around 50 documents**

- **Field investigations including:**

  **16 km of HRS profiles,**

  **10 drillings and 150 geotechnical in-situ tests,**

  **5 Geophysical logging**

  4 Trenches

  3 electrical tomography profiles

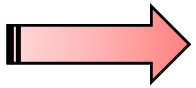
- **Laboratory tests:** **around 230 Characterization and support tests**

- **One synthetic report**

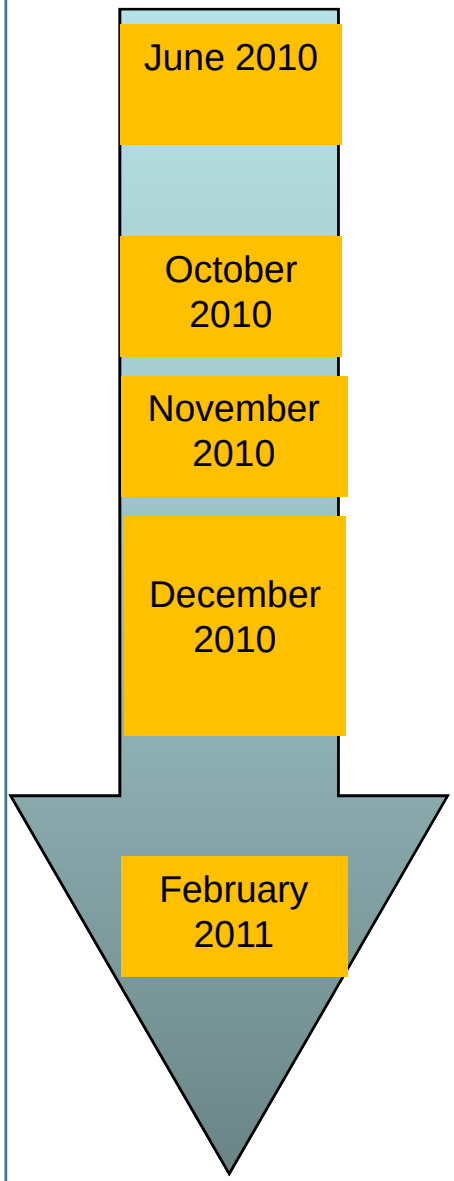
# Libna investigations

**Investigations made in phase 1 (2007-2010) have not provided significant information (including observations in trench).**

**Additional works have been proposed by the consortium and has been approved by GEN including:**

- **Test pits;**
- **Geophysical investigations (electrical tomography, HRS);**
- **Trenching:**  **decision for 3 trenches**

# Investigations in trenches




- **Geophysical investigations**
- **Trenching operations**
  - Fails of the trench 1
  - Trench 3 shown Karstic collapse
- **Observations in trench 2**
  - Evidence of displacements
- **End of investigations in trench 2**
- **Consortium meeting for analyzing the results of investigations**
- **Preparation of Libna fault report**
- **Consortium proposal to GEN for additional investigations**

# Consortium statement on Libna fault

*(Extracted from last agreed version of the Revision1_Version 7 report)*

"Libna fault is not an important structural element of the Krsko basin. Moreover, from its geomorphic expression and its mapped length, it seems unlikely that it is a fault that is capable of generating earthquakes large enough to produce surface fault rupture.

However, recent findings in the trench #2 at the Libna Hill indicate that the Libna fault may be described as capable if capability is defined in line with Safety guide SSG-9 (IAEA, 2010; where capability is not necessarily related to earthquakes on the fault of concern) and if the lower age-estimates of PI,Q formation are taken as relevant."

"Results were not conclusive regarding *two topics:*

- The data does not allow distinguishing between the two alternative interpretations of the observed features in the trenches : the aseismic and the coseismic one.
- Comparison of various age dates of the Plio-Quaternary sediments in the area gives inconsistent results, which sheds doubts about the age of displacement along the Libna fault."

# SITUATION since March 2011

- **The Consortium tried to find consensus on the consequences of findings in Libna trench**
- **On January 24th 2013 GEN received IRSN independent position in a separate letter, with copy to consortium members.**
- **Following this letter, GEN on January 25th asked BRGM and GeoZS to officially clarify their position.**
- **On 19th February BRGM has sent its official position to GEN, considering the possibility of deepen the state of knowledge by performing additional investigations in order to remove ambiguities regarding the origin and the behavior of the Libna fault.**
- **GeoZS letter has been sent to GEN on 13th of February**

# BRGM Recommandations

1. To pursue and widen investigations on Libna fault by examining all the possible hypotheses on the genesis of this fault
2. To better characterize the fault and to narrow down the ambiguities noticed during the first observations notably regarding the age of the Plio-Quaternary sediments and the geometry and location of the fault
3. To perform additional geophysical investigations (i.e. HRS and electrical mapping)
4. To assess the nature of the fault (coseismic or aseismic character). For this purpose microstructural fault zone analysis in near-surface sediments might be performed to elucidate the faulting process
5. To process all available data for producing a 3D structural model of the concerned area. In particular, the structural relation between Libna and Orlica and Artice faults has to be investigated
6. To proceed with enlarged geomorphological investigation
7. To proceed with new trenching to validate (or not) the different interpretations arising from previous trenches
8. If the results of additional investigations confirm the capability of the fault, it is recommended to assess its potential for displacements. Evaluation of the displacements could be implemented through a Probabilistic Fault Displacement Hazard Analysis (PFDHA)