Multi-method applied geophysics
SUMMARY

- State-of-the-art equipment in all geophysical methods
- > 10 permanent employees
- > 100 available and flexible collaborators for large projects
- Worldwide experience
- Strong research and development of hardware and software

TIMELINE

2002 Geo2X Sàrl foundation in Geneva by J. Jenny & J.-M. Frautschi
2006 Relocation to Lausanne (VD)
2012 Status change to SA
2014 AGAP and ISO 9001 certifications
2015 ISO 14001 and OHSAS18001 certifications
2016 Opening of Swiss-german Geo2X branch in Baar (ZG)

OUR COMPANY

EXPERIENCE AND ACTIVITIES

Established in 2002, Geo2X SA has an acquired specialization in applied geophysics. Our activities were firstly aimed at local surveying, which quickly evolved into vibroseis prospection. Since 2012, our focus has been geotechnical identification through joint geophysical methods.

Our global experience is key to find specific solutions for varied issues (hydrogeology, natural resources, landslides, pollution, etc.) in many environments.

A particular effort is put into research and development of new hardware and software, allowing us to have innovative answers to complex situations.

RESOURCES

Our team holds 12 geophysicists, geologists and engineers. When considering large projects, our team can hold up to 120 members.

Client demands are met with quality through exceptional mastery in key software (geophysics and cartography).

Our complete range of equipment meets the highest accurate standards for each geophysical technique.
**Definition**

Applied geophysics is a field of Earth Sciences that uses quantitative methods derived from physics to identify buried geological or anthropological structures.

**Results**

The primary contribution of geophysics is its capacity to provide information on the distribution of given parameters in the ground (seismic velocity, electrical resistivity, etc.).

Geophysical methods allow us to create precise geological models at an optimized cost through regionalization of borehole data.

**Multi-method Applications**

Geological interpretation of a site is constrained through the use of multiple and joint geophysical techniques.

The selected technique depends on the matter and structure to investigate.

This multi-method approach grants the optimization of borehole locations, therefore reducing costs.

**Methods**

**Reflection seismology**
- Geothermal exploration
- Reservoirs
- Stratigraphy, structural
- Faulting

**Refraction / MASW**
- Geological structures
- Landslides
- Geotechnical parameters

**Logs**
- Geotechnics
- Stratigraphy

**Electric tomography**
- Aquifers / Porosity
- Quaternary stratigraphy
- Geological structures

**Gravity exploration**
- Void detection
- Faulting / alteration
- Geothermal reservoirs

**EM - Magnetic exploration**
- Buried waste
- Archaeology
- Buried service networks

**Georadar**
- Void detection
- Archaeology
- Buried service networks
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**Structural Geology**

The ability to illustrate contrasts in density and/or velocity makes reflection seismology an optimal technique for geological cross-section creation and stratigraphic analysis.

The presence of gaps in underground reflectors is useful to identify faults and tectonic features.

**Applications**

- Geological structures
- Stratigraphy
- Faulting
- Geothermal explorations
- Hydrogeology
- Mining prospection
- Reservoirs

**Constraints**

- Sensitive to ambient seismic noise
- Source selection linked to objective
- Low imaging capacity for the first decameters

**Acquisition Fitting**

Our wide range of equipment (sources and receivers) allow us to meet all requirements for any investigation.

Optimized acquisition procedures allow us to guarantee quality imaging for various environments.
VIBRATING SOURCE

In addition to pulse sources, vibrating sources are often used for seismic exploration. These sources transmit adequate signals (frequencies, duration) for specific requirements in each study.

DEEP IMAGING

Vibroseis exploration techniques were designed for petroleum prospecting. Because of its proficiency at great depths (several kilometers), this technique has become essential for geothermal exploration. This is an unmatched technique for stratigraphy and fault recognition.

HIGH FREQUENCIES

Our cutting-edge acquisition procedures, equipment and data processing allow us to provide very high resolution shallow seismic images.

APPLICATIONS

- Oil and gas prospecting
- Deep geothermal energy
- Fault detection, paraseismic
- Stratigraphy
- Structural geology

CONSTRAINTS

- Heavy equipment
- Permitting
- Vibration monitoring, infrastructure protection
In geological framework, it is possible to discriminate lithologies using their seismic velocities ($V_P$ and $V_S$). These values are obtained through seismic refraction and surface waves data processing (MASW).

Ambient noise affects the selection of seismic sources. When correctly adapted, seismic refraction cross-sections are of great quality. Our seismic sources are capable of giving us accurate data for any type of surroundings.

Seismic velocities and lithologies

Joint acquisition

Acquisition procedures for both techniques are similar. Joint analysis of seismic refraction and MASW notably eases geological interpretation.

Simultaneous use of both methods allows us to calculate some of the major geotechnical parameters.

$V_S$ and paraseismic

MASW analysis results are handled to characterize terrains for paraseismic engineering by calculating the $V_{S30}$ value.

This European classification is used in most field recognitions for heavy infrastructure establishment.
Geotechnics and geophysics are complementary domains. Geophysical results are ideal to regionalize geotechnically calibrated data. Mechanical moduli are calculated through the juncture of seismic, gravity and borehole data. These are used in civil engineering structure gauging, geotechnical anomaly detection, and borehole campaign optimization.

- Shear modulus ($V_S$ and density)
- Poisson’s ratio ($V_P$ and $V_S$)
- Young’s modulus ($V_P$, $V_S$, and density)
- Bulk modulus ($V_P$, $V_S$, and density)

**Borehole measurements**
- $V_P$ & $V_S$
- Density
- Resistivity / Conductivity
- Natural radioactivity
- Imaging

Borehole measurements gather borehole logging and well geophysics (downhole, uphole, crosshole). This allows us to characterize multiple parameters of spanned terrains (velocities, densities, resistivities, radioactivity, faulting, etc.). These measurements are ideal proxies to calibrate results from shallow geophysical techniques.
The electrical resistivity of a geological layer changes with its composition, porosity and saturation.

**METHODS**

Measurement procedures for resistivity depends on the type of investigation. Vertical surveys or profiles are the usual outputs of electrical techniques.

Our hardware and software allow us to choose from all acquisition geometries and adapt them to different issues.

**HYDROGEOLOGY AND MINING**

Cross-sections acquired through electrical tomography can be implemented in numerous contexts. Among the main uses, there are:

- Aquifer detection
- Natural resource gauging
- Mineralization (IP)

Innovative techniques allow measurement and output of 3D data, e.g. foundation investigations.
Gravity exploration measures variations in gravity, which depends on density contrasts amongst geological or anthropological objects. The instruments we possess are extremely sensitive, allowing us to identify small-scale objects (microgravity) or define geological structure geometries on a larger scale.

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**Cartography and Profiles**

Gravity surveys are performed as profiles or maps. For example, road or railway constructions require potential void detection along profile lines. Other inquiries, such as large infrastructure construction, call for a cartographic output of gravimetric anomalies. Underlying geology can be modeled using both types of measurements.

**Quaternary Formations**

Specific approaches in gravity exploration are able to precisely quantify mean densities of quaternary formations. This is the first step for stratigraphic reconstruction of sedimentary basins.

**Applications**

- Void detection
- Karst detection
- Alteration, faulting
- Buried structures
- Archaeology
- Density calculations
- Geological structures
- Deep geothermal energy

**Constraints**

- Numerical field model
- Levelling (microgravity)
- Meteorological conditions
**EM - APPLICATIONS**
- Buried waste
- Networks and structures
- Archaeology

**EM - CONSTRAINTS**
- Depth penetration depends on conductivity
- Buried networks, pylons, metallic structures

**GPR - APPLICATIONS**
- Shallow geological structures
- Buried networks and structures
- Archaeology

**GPR - CONSTRAINTS**
- Shallow penetration in high conductivity environments
- Metallic structures

**ARCHAEOLOGY & CONTAMINATED SITES**

Magnetic and electromagnetic exploration techniques are of choice for buried object detection, especially if anthropological. These lightweight and fast methods are optimal for detailed recognition of contaminated sites.

Our state-of-the-art equipment is able to provide images of the first few underlying meters.

**CONDUCTS, VOIDS & ARCHAEOLOGY**

Georadar (Ground Penetrating Radar or GPR) is perfectly adapted for exploration and characterization of buried structures or voids and provides high resolution images on the first few underlying meters or decimeters.

Radar antenna frequencies and type of survey (profile or 3D block) are chosen from study specifics.

Our wide range of equipment allows us to respond to varied requests, especially in archaeology or civil engineering.
A CRUCIAL MEASURE

Quality geophysical results demand extreme precision in terms of positioning.

In order to ensure this precision, our equipment (differential GPS, total station, automatic level) is routinely updated to assess the most recent technological progress.

We also offer specialized services, such as photogrammetry and LiDAR.

VERSATILITY

Our equipment is adjusted based on the surroundings and required precision of each study.

Our experienced surveying teams allow an appropriate response to all types of terrains and surveys:

- Line and point stake-out;
- Line clearance;
- Point, profile and levelling surveys.

CARTOGRAPHY

Surveying datasets are analyzed, verified and mapped in leading software:

- Trimble Business Center;
- ArcGIS.

Graphic and numeric outputs are adapted to meet each of our clients requests.

REQUIRED PRECISION

Reflection seismology
- XYZ - 10 centimeters

Refraction seismology
- XYZ - 10 centimeters

ERT
- XYZ - 10 centimeters

Gravity
- XY - 10cm
- Z - max 0.5cm

EM - Magnetism
- XYZ - 10 centimeters

Georadar
- XYZ - 5 centimeters

Bathymetry
- XYZ - 5 centimeters
- Inertial measurement unit
- Tide gauge
Applications

Bathymetry
- Alpine lake sedimentation monitoring
- Very high resolution and precision seafloor cartography

Profiler & Sonar
- Alpine lake stratigraphy and sediment characterization
- Very high resolution for shallow water imaging

Reflection seismology
- Geological structures
- Sediment-rock contact
- Faulting

Offshore Services

Geo2X not only offers services in terrestrial geophysics, we also provide the following:
- Multi-beam bathymetry;
- Side-scan sonar, sub-bottom profiler;
- Lacustrine and marine reflection seismology.

Bathymetry
Bathymetry measurements produce centimetric seafloor recognitions. This allows us to assist our clients in numerous situations, some of which are the following:
- Structure and work installation, pipelines, navigation security;
- Volume calculation, dredging monitoring, hydroelectric dam draining efficiency.

Reflection Seismology
Reflection seismology has the ability to detect interfaces between sediment and/or rock layers beneath the seafloor. This allows geological identification, sediment thickness determination, and stratigraphic studies.
INNOVATION

Continuous research on cutting-edge solutions to complex issues has encouraged us to develop the following research focuses:

- Participation in the NeTTUN project (European commission). Geological characterization during TBM progression through V_s and GPR seismic imaging;
- Very high resolution shallow water acquisition and data processing through reflection seismology;
- Characterization of deep geothermal reservoirs through innovative 3D gravity techniques;
- Gravity method applications aiming on precise quantification of quaternary formation densities.

As part of these projects, close collaborations have been established with the Universities of Lausanne, Geneva, Neuchâtel, EPFL, ETH, Delft (NL) and Leeds (UK).

SOFTWARE

Thanks to the extensive amount of data generated on our projects, our expertise and the specific requests from each of our clients, we have developed software encompassing most of the geophysical techniques:

- Seismic data processing (reflection and refraction);
- Electromagnetic data acquisition;
- Electrical surveying;
- Vibration monitoring, infrastructure protection.

These products are continuously updated to assess the latest research progress.
EXPERTISE
- Processing/Reprocessing
- Acquisition supervision for all techniques
- Tender
- Technical aid

TRAINING
- Seismic data acquisition and processing (reflection and refraction)
- Electrical data acquisition and processing
- Gravity exploration data acquisition and processing
- Borehole data acquisition and processing

EXPERTISE AND VERSATILITY
Our team’s noteworthy knowledge in all geophysical techniques allows us to provide services of expertise and consulting in the following areas:
- Processing, reprocessing of raw data, data processing supervision;
- Tender (writing and analysis);
- On site supervision for all onshore/offshore geophysical techniques (client representative);
- Technical aid, assistance in choosing adequate geophysical methods for individual situations, geological interpretation assistance.

TRAINING IN GEOPHYSICS
Our engineers at Geo2X are at your service for training in applied geophysics, sharing their years of worldwide acquired experience.

This training primarily addresses geologists or geotechnicians eager to grasp the basics of geophysics, data acquisition and result interpretation.

Training is adjusted as required to meet the specific needs of each of our clients and can be coordinated anywhere in the world.

Adequate and routinely updated course material is available during sessions.
CERTIFICATIONS

In order to guarantee proper management and services, Geo2X has received the ISO 9001 certification in December 2014. This certification is the basis of continuous internal improvement within our company. Client satisfaction follow-up has also been established.

Since 2015, the ISO 14001 and OHSAS 18001 certifications have become an integral part of our work procedures. These certifications set standards regarding environmental management, health, and security during our practices.

We have also received quality certifications issued by the Association pour la qualité en géophysical appliquée (AGAP, France).

HEALTH, SECURITY, ENVIRONMENT

Regardless of the location and objective of our practices, we apply strict security criteria for our employees, third parties, infrastructures and the environment.

We commit to the following:

- Do not harm anyone;
- Protect the environment;
- Efficiently use resources and energy that our practices require;
- Transparent communication;
- Consider local customs;
- Promote the commitment of all to respect and follow our policy;
- Promote these engagements to our subcontractors.

By strictly respecting these engagements, we create trusting affiliations with all our partners, clients, employees and third parties.