

BRGM, French Geological Survey

Test facility for ground heat exchangers

Contact details

Orléans, France

<http://www.brgm.fr/>

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General description of the activities

Since 2009 the French Geological Survey BRGM operates a test facility for ground heat exchangers (GHE) located in Orleans, France. The facility aims at better understanding thermal, hydric and biogeochemical interactions of the GHE with their environment and at developing efficient, competitive energy systems integrating GHE. Research is carried out in partnership with academic institutions and industrial partners.

Overview of facilities

Laboratory testing facilities

Design and implementation of experiments at the field and laboratory scales, e.g. heat and moisture transfer in the soil surrounding near surface ground heat exchangers (GHE), or geochemical and microbiological modifications induced by GHE.

Field testing facilities

- Borehole, horizontal and slinky coils heat exchangers equipped with local (Pt100) and distributed temperature sensors (fiber optics with Raman technology for distributed TRT).
- Piezometers for aquifer follow-up (temperature, geochemistry) close to borehole heat exchangers.
- Modular thermodynamic machinery to produce realistic heating and cooling loads accounting from various building types (housing, tertiary, etc.).
- Fully equipped weather station, temperature sensors, tensiometers, humidity sensors in the unsaturated zone (0-2 m depth) to better understand the influence of climatic conditions and soil properties (e.g. sand and clay content) upon the efficiency of shallow GHE.

Computational capacities

- Thermal dynamic simulations of ground-sourced heat pumps (GSHP) in MATLAB, TRNSYS, Python relying on fast semi-analytical thermal models of ground heat exchangers (including geostructures).
- Multicriteria (technical and economic) optimization of GSHP
- Hydro-thermal modelling of ground heat exchangers in Comsol-Multiphysics, Feflow and Hydrus (saturated and unsaturated zone, heterogeneous media).
- GIS mapping of near surface geothermal energy potential.

Key projects

- GECKO, funded by French Research Agency ANR (2011-2015): development of a semi-analytical thermal pile heat exchanger model accounting for concrete thermal inertia. Distributed thermal monitoring (fiber optics) of a PHE during in-situ testing.
- MICROGEO, funded by French applied research program FUI (2012-2015): development of a cost-effective ground-source heat pump for well insulated single houses producing heating, domestic hot water and cooling. Partnership with industrials (EDF, CIAT, Terrendis France). BRGM has tested innovative GHE, monitored the installation in real conditions for 2 years, and developed an easy-to-use online sizing tool for installers (<http://plateforme-geothermie.brgm.fr/actualites/2017/01/un-outil-en-ligne-pour-dimensionner-les-echangeurs-geothermiques>).
- CORGEOSOLA, funded by Region Centre Val de Loire (2013-2016): better understanding the influence of unsaturated zone characteristics and climate upon slinky coil heat exchangers efficiency.
- GRETA, funded by European Alpine Space Program (2016-2018) aims at increasing the knowledge about shallow geothermal energy in the Alpine Space and developing methods for its integration into local energy plans.

Key references

Peer-reviewed articles :

- Chalhoub M., Bernier M., Coquet Y., Philippe M., 2017. A simple heat and moisture transfer model to predict ground temperature for shallow ground heat exchangers, *Renewable Energy*, Vol. 103 (2017): 295-307.
- Nouveau M., Grandjean G., Leroy P., Philippe M., Hedri E., Boukcim H., 2016. Electrical and thermal behavior of unsaturated soils: experimental results, *Journal of Applied Geophysics*, Vol. 128 (2016): 115-122.

Communications in professional reviews :

- Maragna C. 2015. Influence de la durée d'un test de réponse thermique sur sondes géothermique verticale sur l'incertitude des paramètres estimés, *revue CVC n°890*, déc. 2015.
- Philippe M., Juillac L. 2014. Une installation de test de corbeilles géothermiques sur la plate-forme expérimentale du BRGM, *revue CVC n°885*, oct. 2014.

Congress communications:

- Juillac L., 2014. Simulation du fonctionnement d'une PAC résidentielle raccordée à un échangeur géothermique horizontal réel, 4^{ème} Congrès Français des Pompes à Chaleur, Paris, 18 septembre 2014.
- Nouveau M., Philippe M., Grandjean G., Tabbagh A., 2014. Détermination de la conductivité thermique du sol à partir de mesures réparties de température par fibre optique, 9^{ème} colloque GEOFCAN, Paris, 13-14 novembre 2014.
- Chalhoub M., Philippe M., Coquet Y., 2015. A Field Experiment to assess the Influence of Heat and Mass Transfer at the Soil Surface on Shallow Ground Heat Exchanger Performances, *World Geothermal Congress*, Melbourne, Australia, 19-25 April 2015.
- Maragna C., Rachez X., 2015. Innovative Methodology to compute the Temperature Evolution of Pile Heat Exchangers. *World Geothermal Congress*, Melbourne, Australia, 19-25 April 2015.
- Philippe M., Cauret O., 2015. Essais d'échangeurs enterrés dédiés aux installations géothermiques de très faible puissance, 5^{ème} Congrès Français des Pompes à Chaleur, Paris, 17 septembre 2015.
- Philippe M., Chalhoub M., Maragna C., Juillac L., 2016. Experimental studies for improving the performances of compact coil ground heat exchangers, *European Geothermal Congress*, Strasbourg, 19-25 September 2016
- Maragna C., 2016. Development of a numerical Platform for the Optimization of Borehole Heat Exchanger Fields, *European Geothermal Congress*, Strasbourg, 19-25 September 2016

Additional information, remarks

- BRGM staff members in geophysics (electric, seismic, etc.), geology, hydrogeology, and geochemistry can be involved in any R&D project.

Ongoing PhD theses, research

(none started yet)

<i>Potential supervisors for thesis, PhD thesis, ...</i>
- Mikaël Philippe (m.philippe@brgm.fr), test facility project manager - Charles MARAGNA (c.maragna@brgm.fr) and Maha CHALHOUB (m.chalhoub@brgm.fr), research engineers