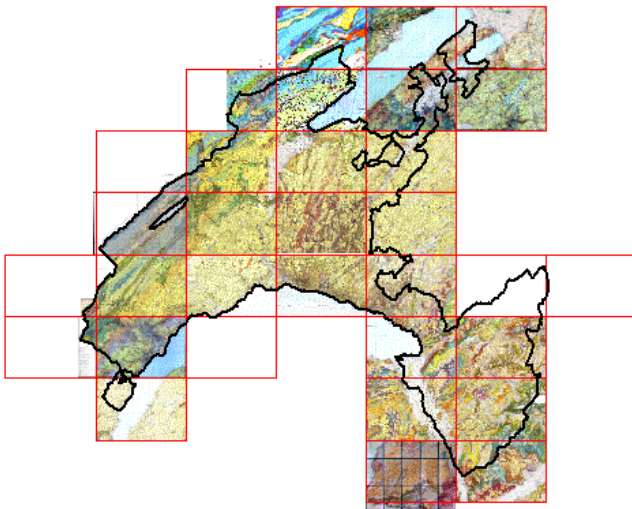


The geotype concept to develop GIS oriented analysis in engineering geology applications

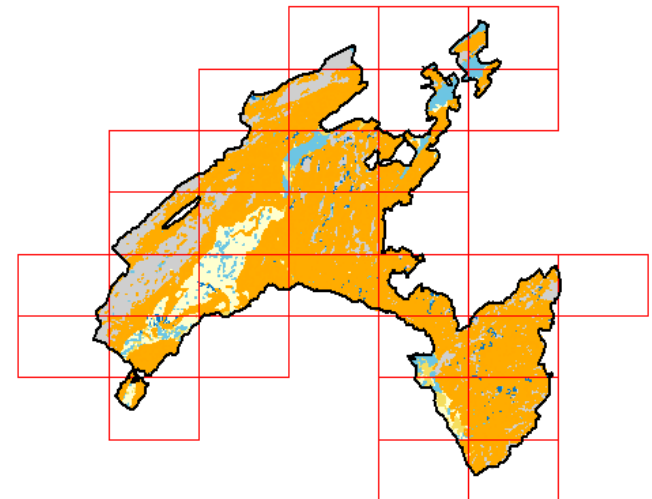
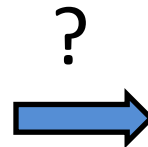
P. Turberg, A. Parriaux : *Ecole Polytechnique Fédérale de Lausanne (EPFL) - Laboratory of Environmental and Engineering Geology*

M. Kalbermatten, F. Golay : *Ecole Polytechnique Fédérale de Lausanne (EPFL) – Geographical information systems laboratory*

J.-M. Lance: *Etablissement d'assurance contre l'incendie et les éléments naturels du Canton de Vaud.*



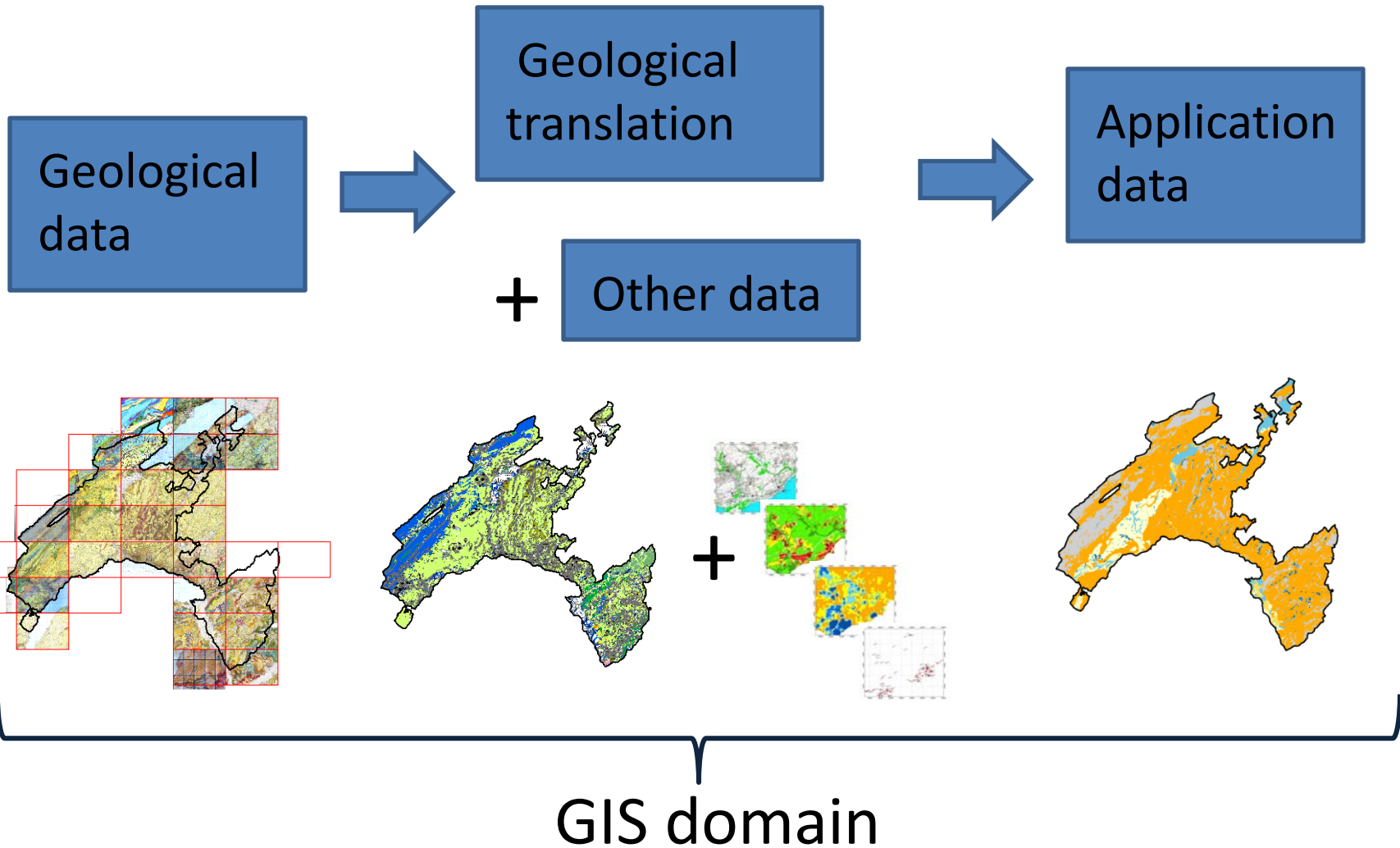
Base map



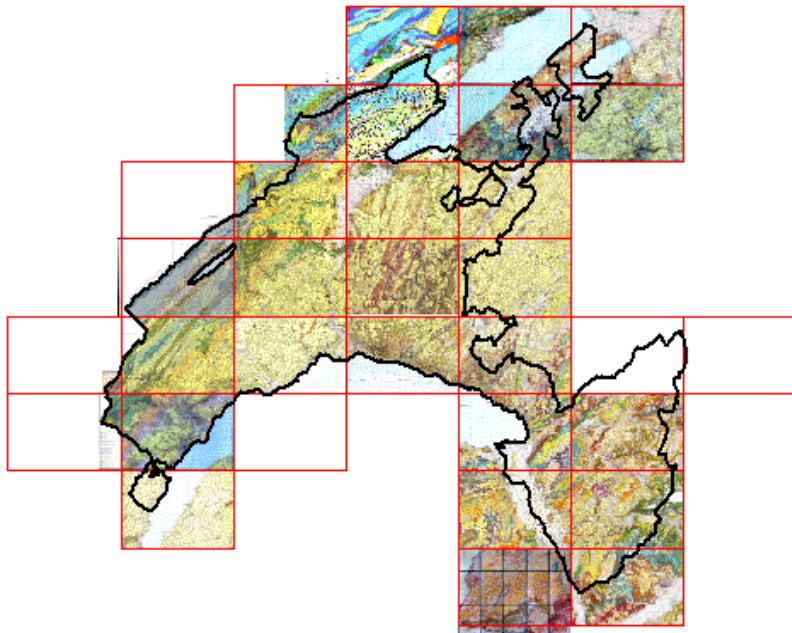
Application map

Outline

- I. Rationale
- II. Proposed method: geotype & SIG
- III. Application at the regional scale
- IV. Resulting GIS maps
- V. Discussion and Conclusions



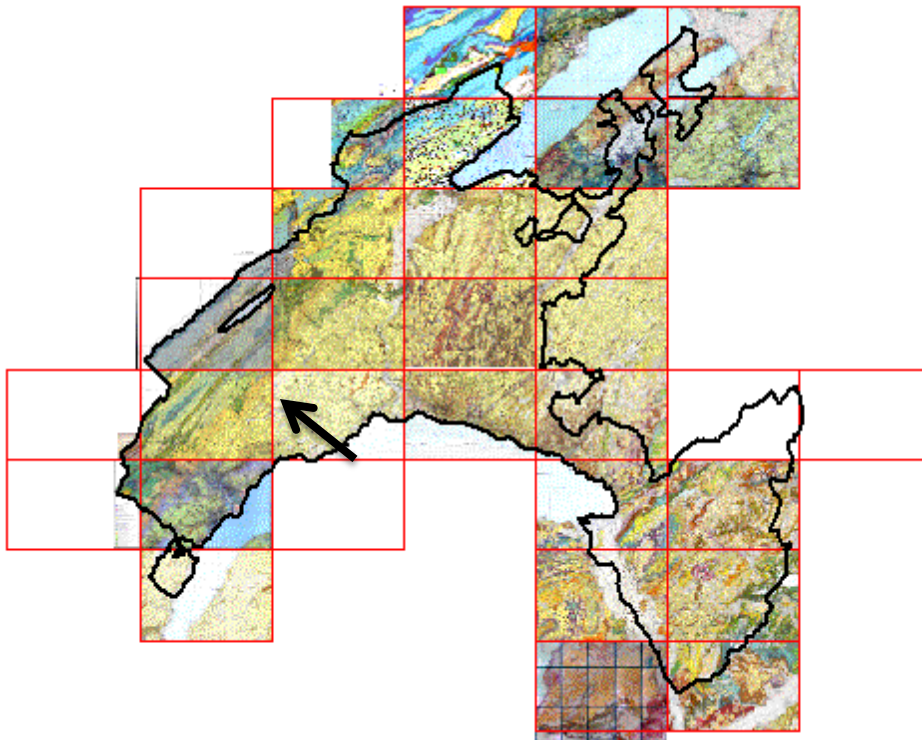
Is a geological translation needed ?



Original geological
data

- heterogeneous in time, cartographic approach and cartographic data
- local and complex information

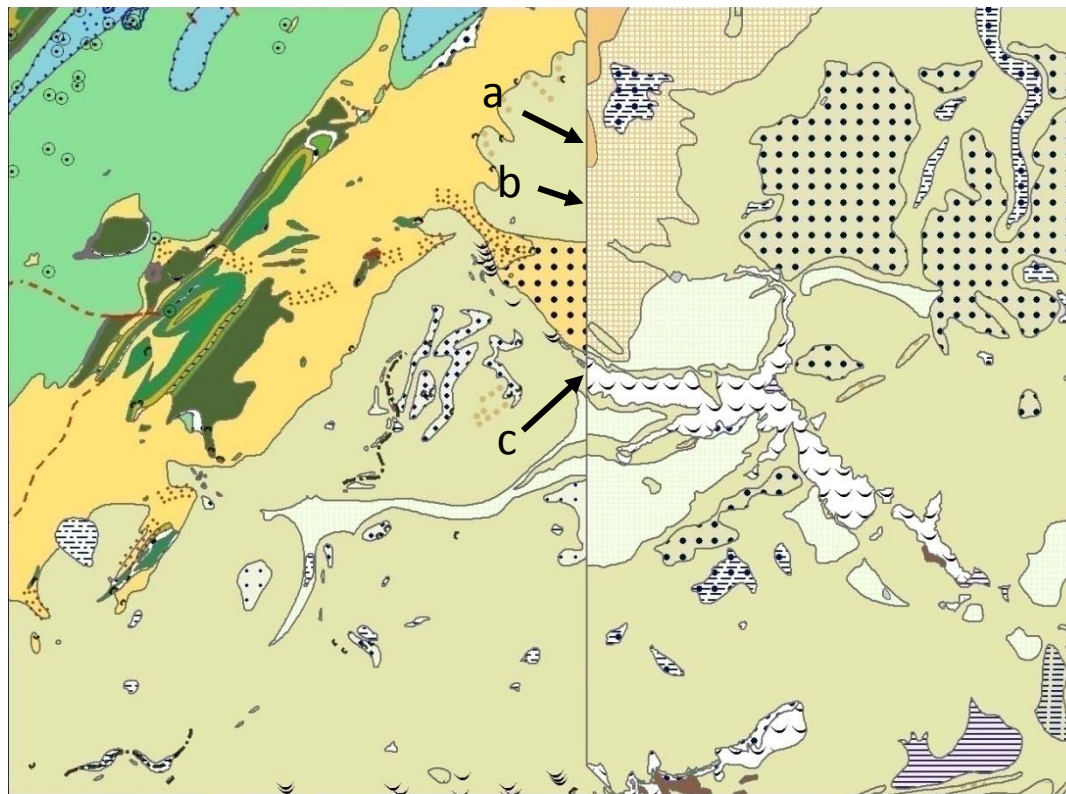
« heterogeneous in time, cartographic approach and cartographic data »



- **32 maps are concerned**
 - **Chronology of these maps:**
 - Until 1950
 - Until 1970
 - Until 1990
 - Until 2007
- ⇒ **Quaternary deposits**
- ⇒ **Associated phenomena**
- ⇒ **Discordance at the limits of maps**

Why not using directly the information from geological maps ?

Frequent not concurring geological information between maps



Examples:

- a) Alpine moraine (left) & Jura moraine (right)
- b) Ground moraine (left) & Jura fluvioglacial deposit (right)
- c) Stable moraine (left) & unstable moraine (right)

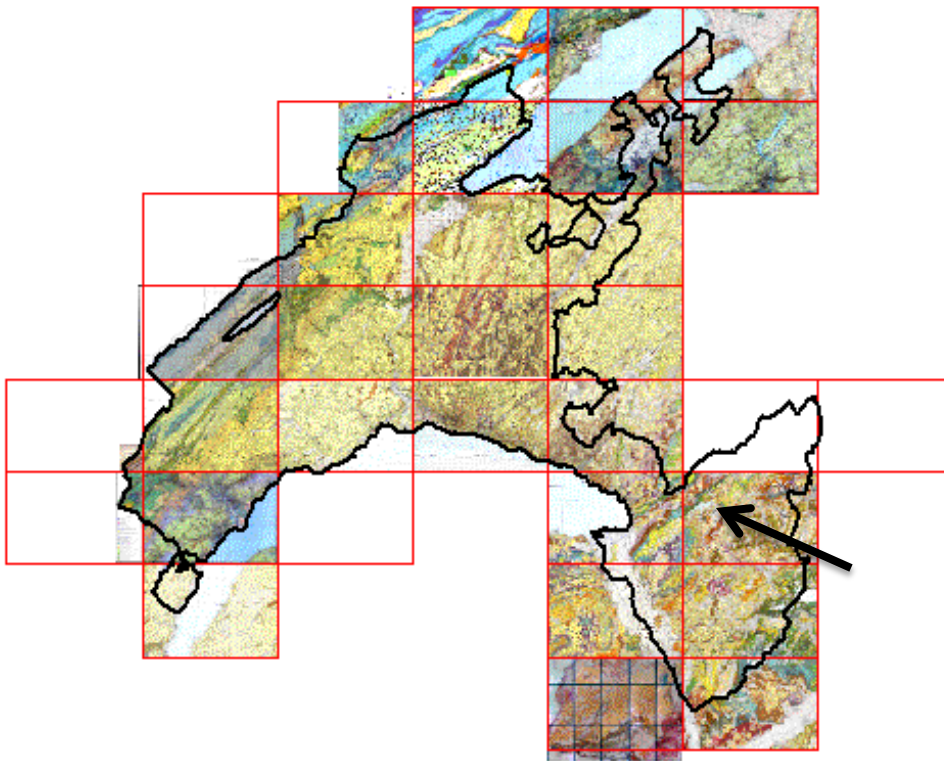
Extrait des cartes 1241 et 1242 de l'Atlas géologique de la Suisse au 1:25'000 (légendes non indiquées)

Map 1241 (Marchairuz)

Map 1242 (Morges)

2 km

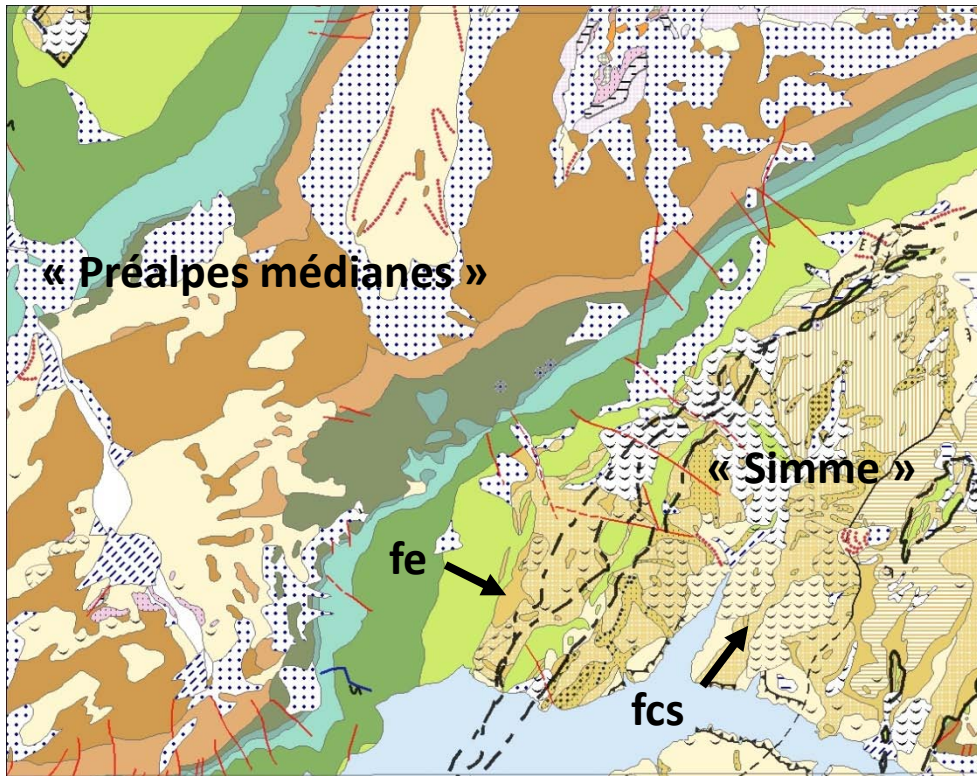
« local and complex
information »



- ⇒ **Local differences not always necessary**
- ⇒ **Chronostratigraphic differences not always necessary**
- ⇒ **Differentiation of tectonic units not always necessary**

Why not to use directly the information from geological maps?

Geological information is too complex for the actual needs of territorial management



Extrait de la carte 1265 de l'Atlas géologique de la Suisse au 1:25'000 (légendes non indiquées)

Map 1265 (Les Mosses)

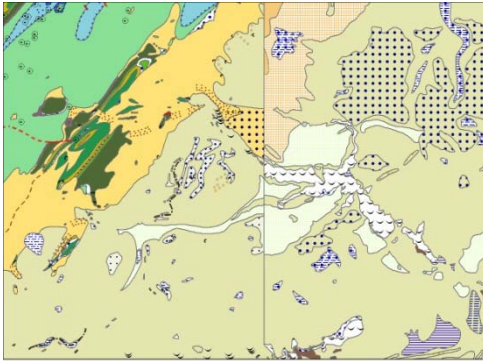
Examples:

- Differentiation of tectonic units: Préalpes médianes thrust nappe (left) and Simme s.l nappe (right)
- Chronostratigraphic differentiation : Eocene flysch (fe) and late cretaceous flysch (fcs)

1 km

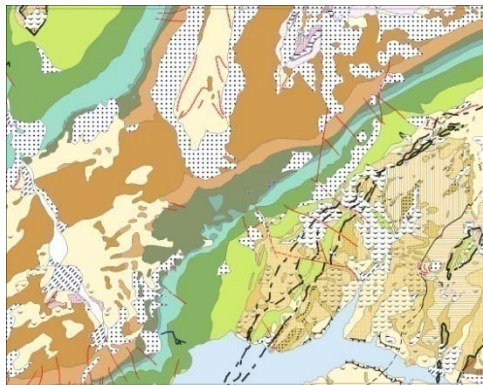
If geological maps are directly used for application maps ?

Not concurring geological information between maps



Extrait des cartes 1241 et 1242 de l'Atlas géologique de la Suisse au 1:25'000 (legendes non indiquées)

Too complex geological information



Extrait de la carte 1265 de l'Atlas géologique de la Suisse au 1:25'000 (legendes non indiquées)

- Regional approach is more difficult
- More difficult to combine with territorial objects
- More complex extraction of information (GIS)
- Difficult to integrate in a semi-automatic analytic process
- Model is less optimized for a given applications



GEOLOGICAL TRANSLATOR
« GEOTYPES »

What's a geotype ?

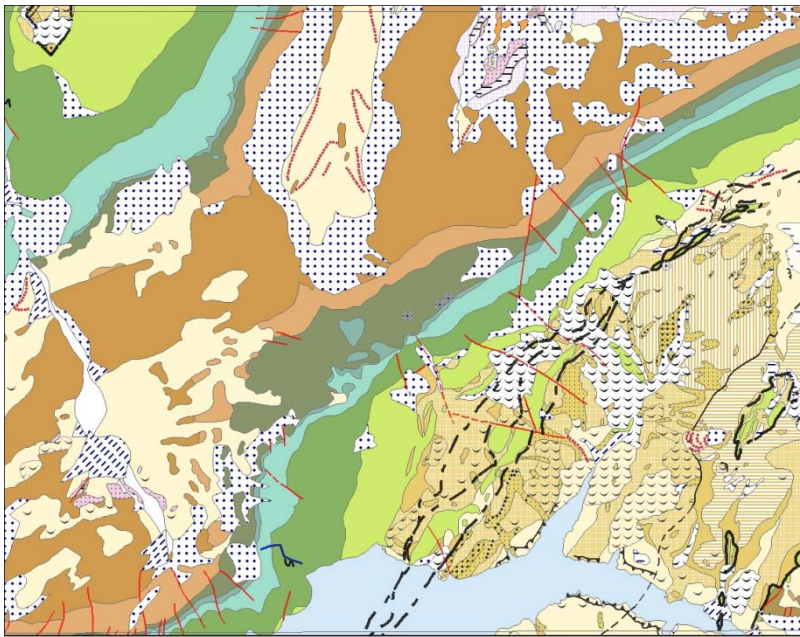
→ A « geotype » is a lithostratigraphic or genetic group with similar properties

A geotype is qualified according to the way it belongs to three levels, from the more to the least detailed:

| | Exemple 1 | Exemple 2 |
|--|--|--|
| A general level made of 5 major groups of geological formations. | Hard rocks s.l. | Alluvial deposits s.l. |
| An intermediate level made of 11 groups of lithological formations | Carbonated rocks | Lacustrine deposits |
| A detailed level made of 41 geotypes... ...and a unique code associated to each of them | Dolomitic limestones CD | Ground lacustrine deposits LF |

Example of a translation geology - geotype

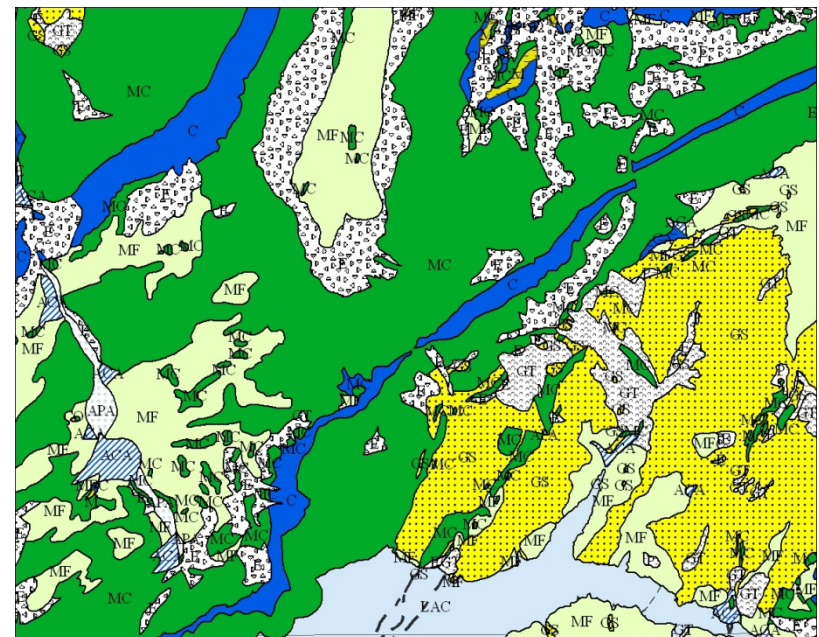
Exemple of a too complex geological information for the actual needs of territorial management



Extrait de la carte 1265 de l'Atlas géologique de la Suisse au 1:25'000 (légendes non indiquées)

Map 1265 (Les Mosses)

Geological map



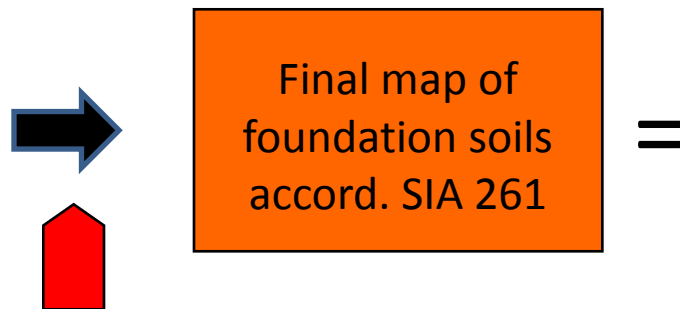
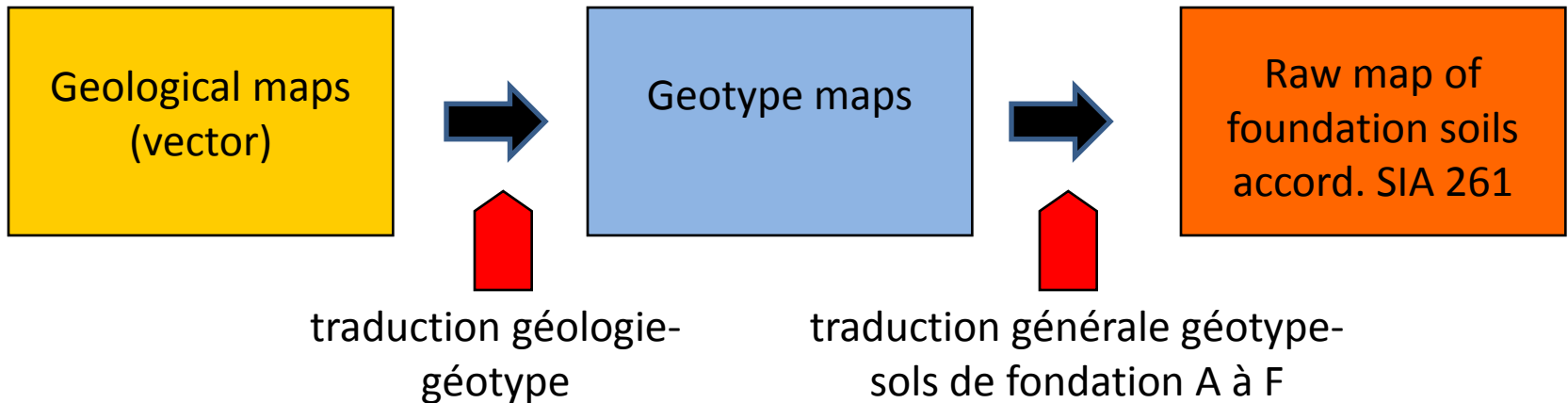
Extrait de la carte nationale 1265

Map 1265 (Les Mosses)

Geotype map

Realized application

Map of foundation soils of the canton of Vaud, Switzerland (framework: seismic microzoning)

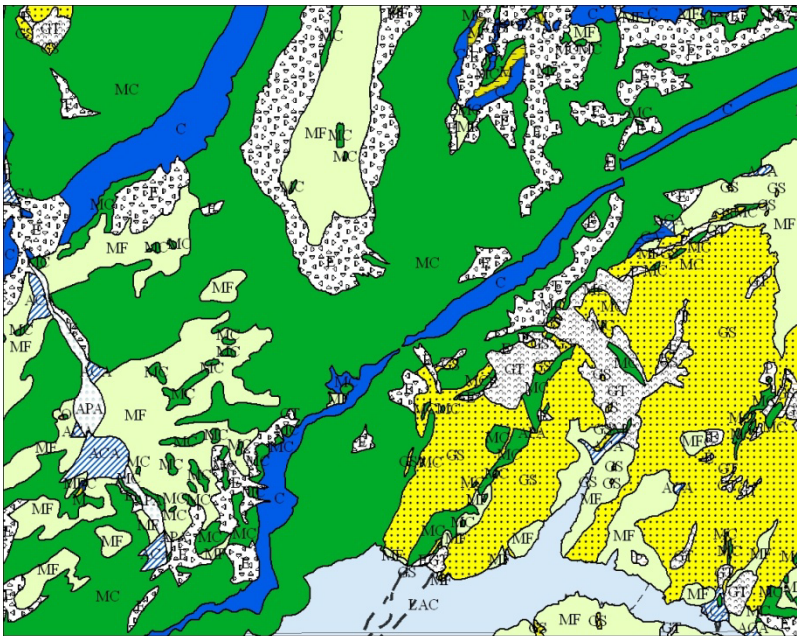


| Classe de sols de fondation | Description |
|-----------------------------|---|
| A | Roches dures (p.ex. granite, gneiss, quartzite, calcaire siliceux, calcaire) ou roches tendres (p.ex. grès, conglomérats, marnes du Jura) sous une couverture maximale de 5 m de sol lâche. |
| B | Dépôts de graviers grossiers et sables cimentés et/ou roches meubles surconsolidées d'une épaisseur de plus de 30 m. |
| C | Dépôts de graviers et sables normalement consolidés et non cimentés et/ou matériau morainique, d'une épaisseur de plus de 30 m. |
| D | Dépôts de sables fins, silts ou argiles non consolidés, d'une épaisseur de plus de 30 m. |
| E | Couche alluviale superficielle des classes de sols de fondation C ou D d'une épaisseur comprise entre 5 et 30 m, surmontant une couche plus rigide des classes de sols de fondation A ou B. |
| F1 | Structures sensibles et dépôts organiques (p.ex. : tourbes, craie lacustre) d'une épaisseur supérieure à 10 m. |
| F2 | Glissements de terrain actifs ou susceptibles d'être réactivés. |

Realized application

Map of foundation soils of the canton of Vaud, Switzerland (framework: seismic microzoning)

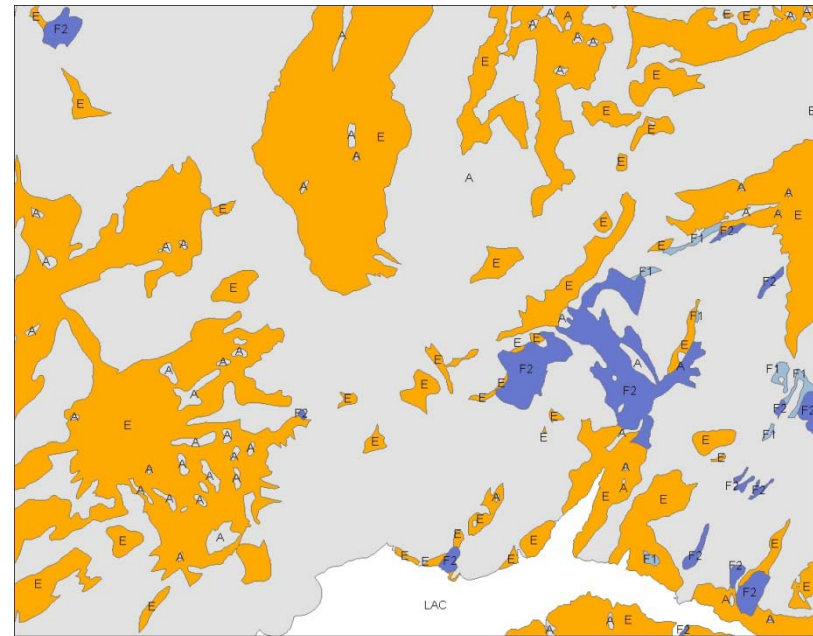
Translation of geotype into foundation soils



Extrait de la carte nationale 1265

Map 1265 (Les Mosses)

Geotype map

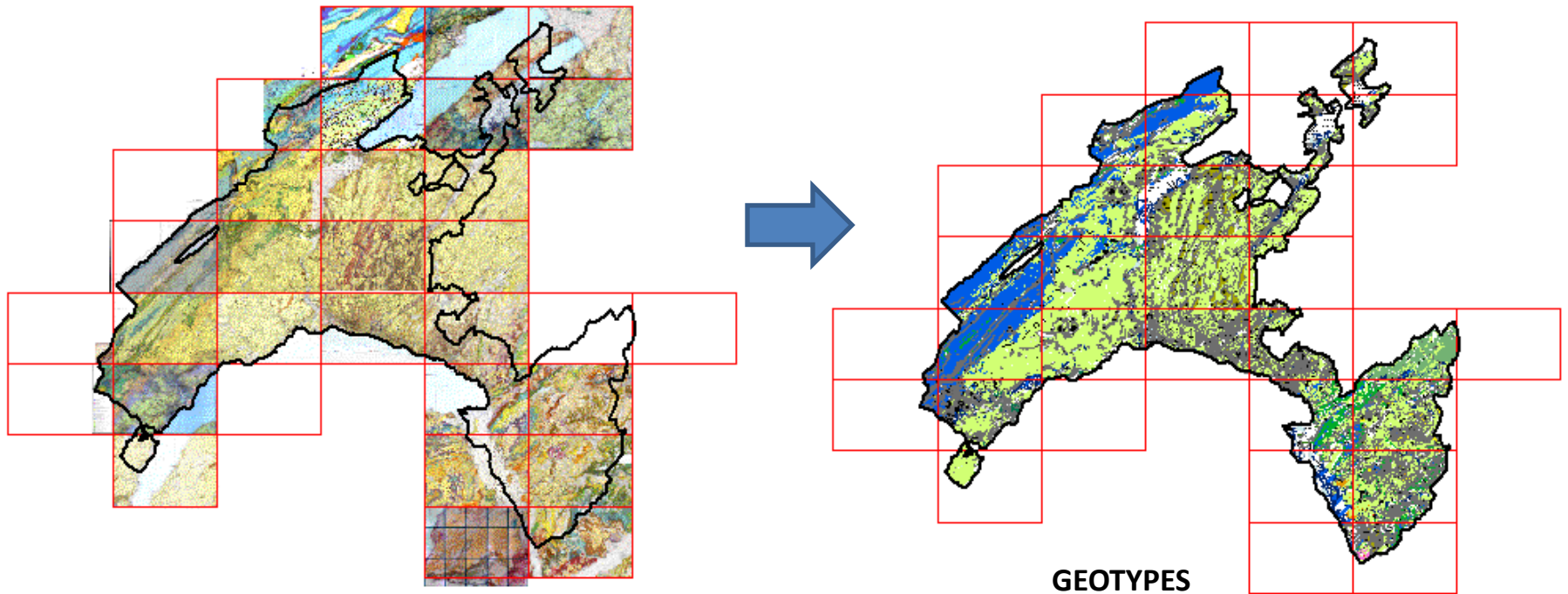


Extrait de la carte nationale 1265

Map 1265 (Les Mosses)

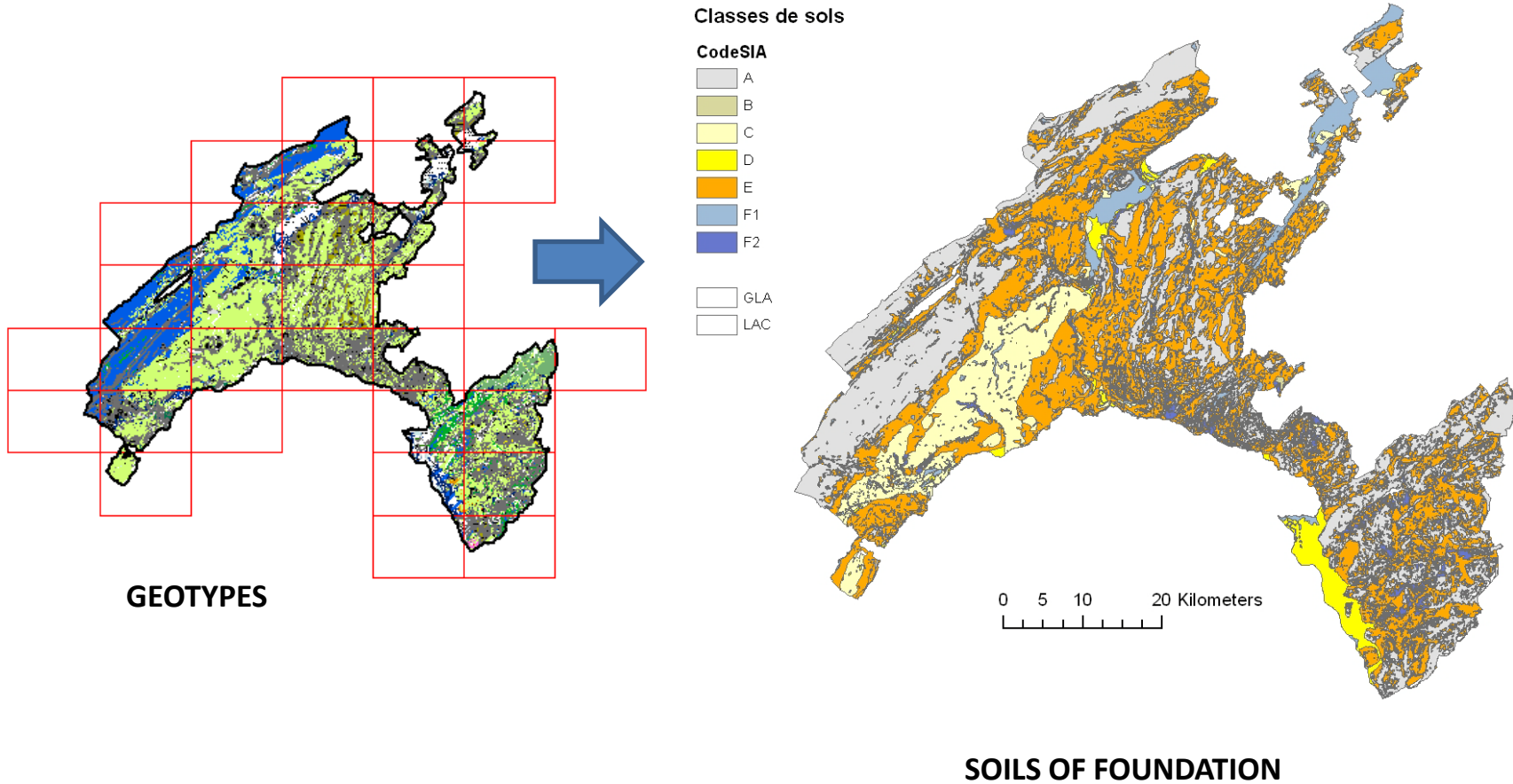
Foundation soil map

Results at the scale of canton of Vaud

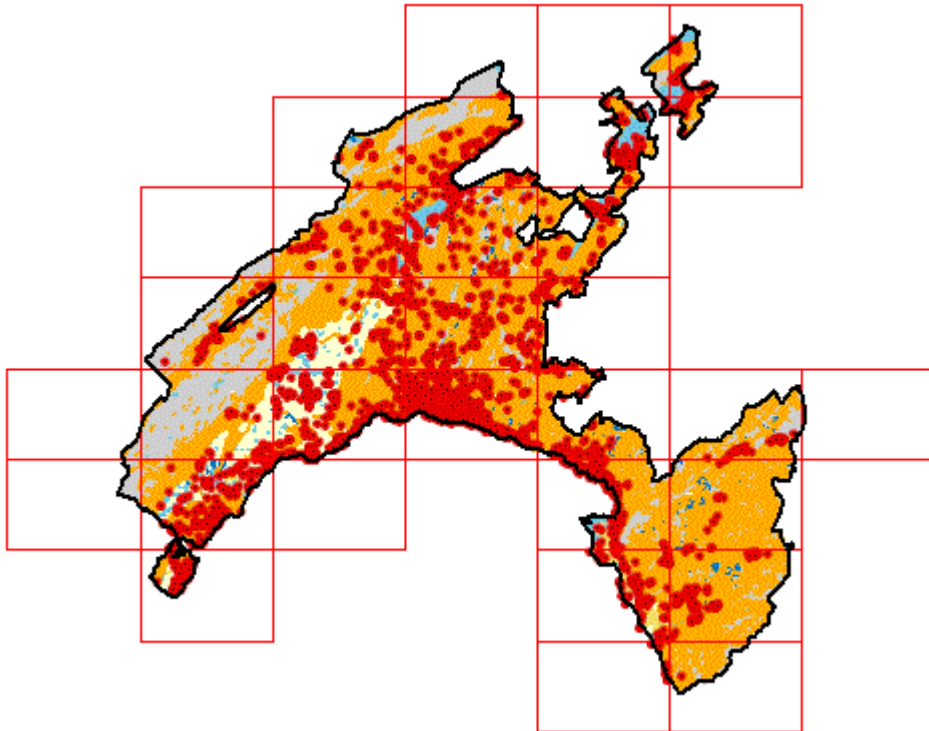


- Mapping over 3200 km² - 6 different contractors working in parallel

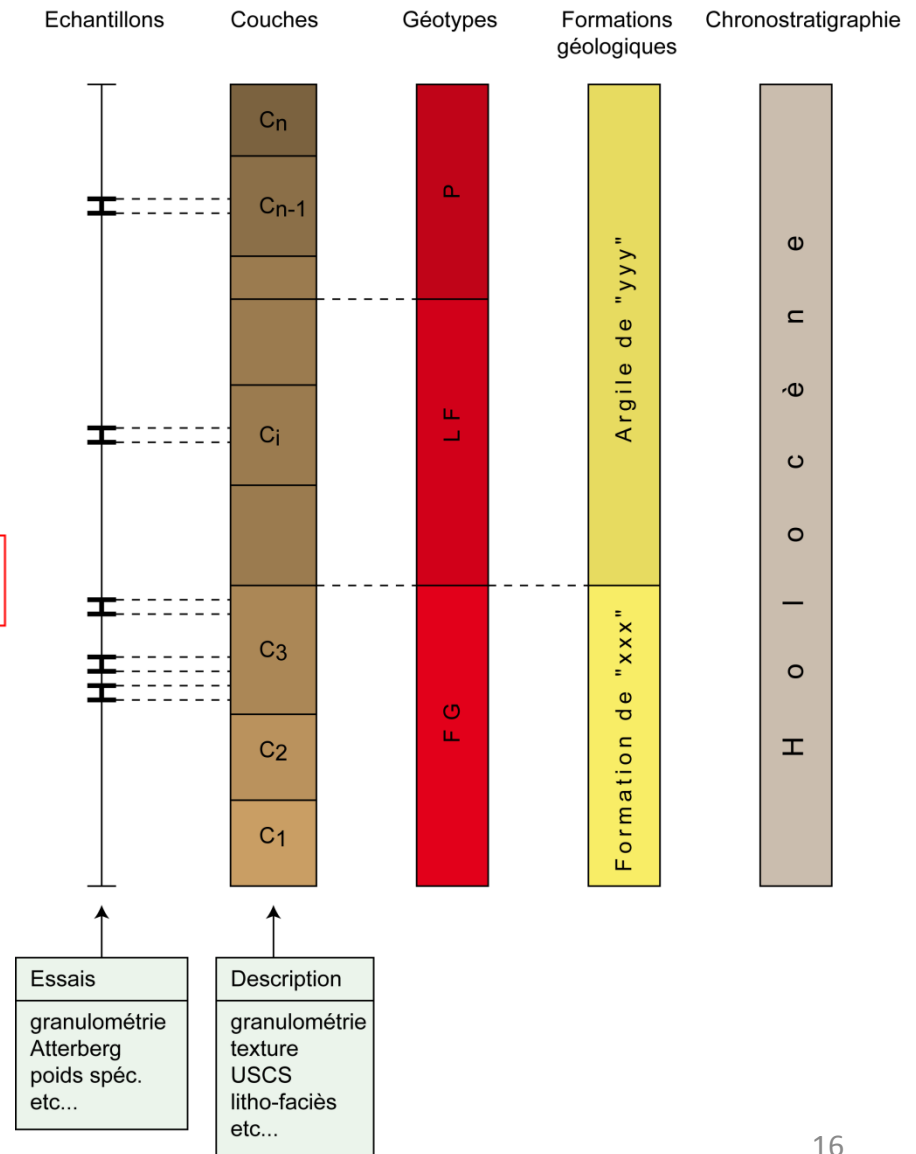
Results at the scale of canton of Vaud



Integration of borehole data



3000 boreholes



Contribution from GIS

| Conditions | Answer | GIS input |
|--|---|--|
| With existing data | Geological maps + boreholes + others | For quality checking of existing data |
| With good reliability, traceability and coherence | Geotype, local experts, explicit steps | For traceability and results control |
| Over a minimum time period | Parallel cartographic work | For semi-automatization of tasks |
| With acceptable cost investment | Two cartographic phases | For optimizing the surface to be mapped |
| With good maintenance and diffusion capabilities | Explicit translation, link with borehole database | For actualization and on line consultation |

Comments on geotypes

- Geotypes appear to be robust and allow an effective adaptation of the base geological information to present needs in **regional territorial management**.
- Geotypes were developed for the geological context of the canton of Vaud but can certainly be **generalized**.
- Geotypes allow an advanced GIS exploitation of geological data and therefore valorize these.
- Geotypes aren't a base mapping method **and cannot replace standard geological surveys**.

Perspectives

- Use this geotype-GIS method in other domains (groundwater, natural hazard, geothermal potential, archeology, etc.)
- Multiple possibilities to associate geological information to other geographical information (modelling)
- Use in geological database
- Didactic tool to facilitate geological diffusion

Thank you for your attention !

