History of Geology in Liechtenstein

Dr. Cyril Deicha[a], Dr. Igor Deicha[b]

[a] Member of COFRHIGEO Paris; European Physical Society section Liechtenstein, POB 705, CH-9490-Vaduz-FL, Switzerland; presenting author: cd@nwf.li

[b] Member of Comité national français de Géographie.

Introduction

In comparison to other countries, Liechtenstein is not well known in the world, because there is not very much scientific literature on the topic. The history of geosciences of this two century old principality deserves a schematic overview: First let's describe the landscape and its geological history from the oldest stones ever found, to the rocks which are presently in formation.
Then with some examples of human investigations, we will try to put some historical landmarks .
As a conclusion, we made a list of useful institutional actors, and a short comparison to the neighbouring countries. Bibliography and some interesting links are quoted in the footnotes (most literature about Liechtenstein is in German).

-A- Geological history

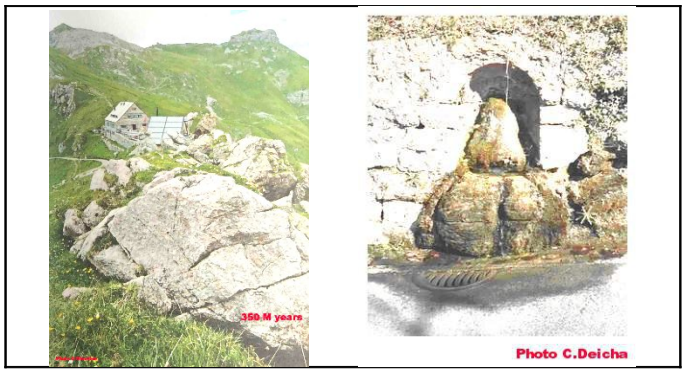
-1- : Liechtenstein ideal terrain for Geosciences

Liechtenstein is an alpine country of 160 km^2 with an "*interesting geological variety*" [1] It is also "*a paradise for the geographer*" [2] .

-2- Evolution in progress

Left: The oldest rock of Liechtenstein, the Bettlerjoch-breccia 350 million years old (Pfälzerhütte)

Right: The newest rocks formed by current tuffa-deposits. A barely 50 years old petrifiyng fountain (Schlossstrasse) [3]



Landscape evolution is visibly in continuous progress :

1 Miescher, D. (2014). *Geologie Liechtensteins.* Alpenland Verlag, Schaan, 142 p. ISBN 978-3-905437-36-2.

2 Deicha, I. *Das Grenztal des Alpenrheins, ein Paradies für den Geographen* ; NWF , Vaduz 2002 ;

Link : https://docplayer.org/47885256-Allgemeines-1-1-periodika-bibliographien-allgemeines-6-statistisches-jahrbuch-fuerstentum-fuer-volkswirtschaft-2002-xiv-375-s.html

3 Photo „petrifying fountain" from „ Bericht 2020 des Präsidenten des Vereins NWF" , p. 3; Naturwissenschaftliches Forum Vaduz Febr 2021 . Link :https://dachverband.li/application/files/1516/1350/9438/2021OnlineNWFjahresbericht.pdf

Erosion (The famous touristic trail *Fürstensteig* must be rebuild each year) , Alluvions in the Rhine change constantly , the petrifiying fountain is growing.

Catastrophic changes occur from time to time:

Mud avalanches (*Rüfen),* Rhine floodings and strong earthquakes [4] are not very frequent (P.S. *Surprisingly the last one occurred ... some days ago and is very popular on Youtube*. [5])

-B- History of human investigations:

-1- Utilitarian:

Since the Middle Ages stone quarries are exploited at several places[6] . At least four medieval castles were build with this material.

(Photo *the Castle of Vaduz* [7])

Two hundred years ago, people eventually mined and exported some other mineral resources . Gypsum was extracted in quarries above Masescha and milled in Vaduz Mühleholz. *In 1800 gypsum was Liechtenstein's most important industrial export product* [8] . Iron ore was extracted in Valorsch until the 17th century. Smelted with charcoal they produced a small quantity of steel.[9]

In the beginning of the 20th century the construction of new roads, drainage channels and hydro-electric power-stations provided new geological knowledge . The Liechtensteiner Kraftwerke (LKW) began to work in 1927 (Lawenawerk, Saminawerk, Pumpspeicherkraftwerk) . A road tunnel was digged in 1947. There were scientific consequences e.g *"crystals with fluid*

4 Deichman, N. (2011) (Hrsg). *Earthquakes in Switzerland and surrounding regions (1996-2010).* Swiss Seismological Service, ETH Zürich.

5 An sismic tremor occurred … just as we were writing this paper (1.9.2022) See: Albrich S. „*Seism interrupting Parliament debate about Earthquake Insurance* „ Liechtensteiner Volksblatt 02.09.2022. Video https://www.youtube.com/watch?v=FvDdRI0iOGc

6 Frommelt, A. (1934). *Steinbruch Limsensneck.* Jahrbuch Historischer Verein Liechtenstein.

7 Photograph from https://www.mindat.org/loc-263790.html [Note the cited reference in this link : Sella, C., Deicha, G. (1970) Fractographie électronique sur un échantillon de calcite de Vaduz (Principauté du Liechtenstein). Schweizerische Mineralogische und Petrographische Mitteilungen: 50: 155-158.]

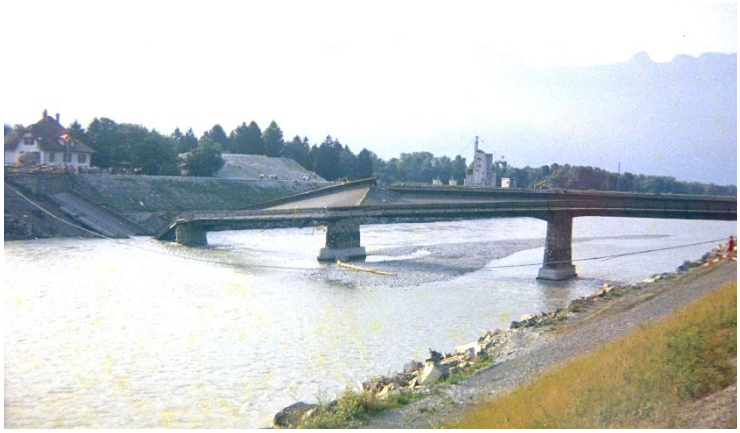
8 Paul Vogt: Brücken zur Vergangenheit - ein Text und Arbeitsbuch zur liechtensteinischen Geschichte 17. bis 19. Jahrhundert. (264 Seiten), Schulamt des Fürstentums Liechtenstein, Vaduz 1990) https://www.eliechtensteinensia.li/viewer/fullscreen/000472669/218/

9 Hansjakob Falk, "Stachler", Stand 31.12.2011 in Historisches Lexikon des Fürstentums Liechtenstein online (eHLFL) https://historisches-lexikon.li/Stachler

inclusions, were discovered in Triesen flysch fissures, they were collected from the dumps of the underground penstock, connecting the Steg reservoir in Samina valley to the power station in Vaduz." [10]

Half a century later soil drillings were performed to get groundwater or more recently to investigate the possibilities of geothermy, [11]

In comparision to other countries "*Liechtenstein has few natural resources, aside from alluvial gravel used by the concrete industry. Gravel extraction from the river interfered with groundwater flows and was banned after 1972. Historically, peat was extracted in the north of the country, but this has also stopped" [12].* Indeed gravel extraction had even caused a bridge-collapse in the seventies. (Photo C.& I.Deicha)



-2- Scientific

Geosciences in Liechtenstein

The exploration by foreign geologists began in the 19th century [13]
Due to the smallness of the country, there is no geological nor geographical institute, but individual researchers with foreign scientific affiliations do a good work, principally in German[14], but also in other languages [15]

From time to time, Liechtenstein was represented at international scientific meetings (*e.g.*, 19th and 21st International Geological Congress). That question is not yet completely studied [16]

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10 Citation from: https://www.mindat.org/loc-263789.html

11 Amt für Umwelt & Naef, H. (2011). *Nutzungspotential der Tiefengeothermie in Liechtenstein*. Infoblatt2011.Vaduz

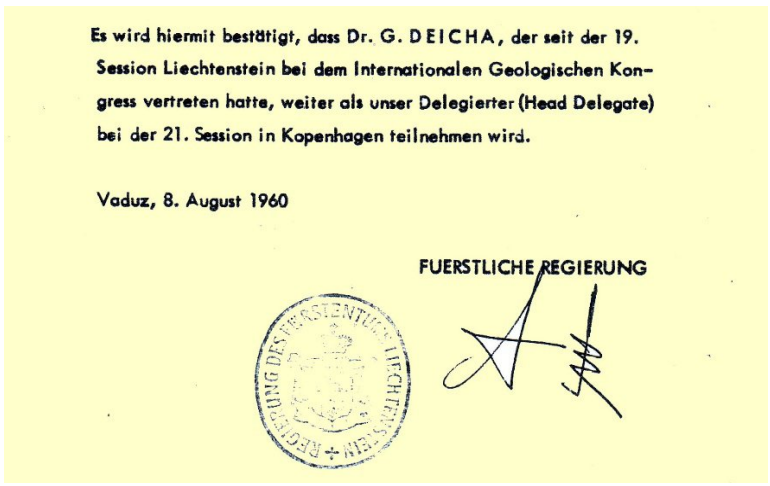
12 Wikipedia https://en.wikipedia.org/wiki/Geology_of_Liechtenstein

13 Wanner, G. (2011). "Geologie", *Historisches Lexikon des Fürstentums Liechtenstein online (eHLFL).* https://historisches-lexikon.li/Geologie.

14 Allemann, F. (1956). *Geologie des Fürstentums Liechtenstein unter besonderer Berücksichtigung des Flyschproblems.* Jahrbuch Histor. Verein Liechtenstein. Inaugural Dissertation Univ. Bern

15 in French , one of the earliest scientific works was completed in 1980 (Igor Deicha "La vie Rurale Alpine" doctoral thesis in geography, univ. Paris X)

16 Liechtensteiner Vaterland 26.07.2017 p. 8 „*Bezug zu Liechtenstein noch unerforscht"* in *„Dr. Deicha hält die Eröffnungsrede" ;* https://deicha.li/application/files/4715/0425/1492/2017Vaterland26JuliAusschnitt.jpg

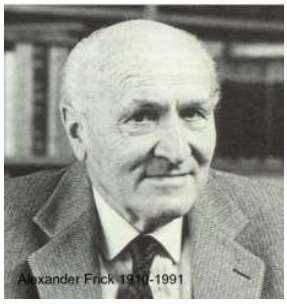


Es wird hiermit bestätigt, dass Dr. G. DEICHA, der seit der 19. Session Liechtenstein bei dem Internationalen Geologischen Kongress vertreten hatte, weiter als unser Delegierter (Head Delegate) bei der 21. Session in Kopenhagen teilnehmen wird.

Vaduz, 8. August 1960

FUERSTLICHE REGIERUNG

We recently found in our family archive this document signed by Prime Minister A.Frick, certifiyng the participation of Liechtenstein in two International Geological Congresses.



As an example we may evoke the developement of the fluid inclusions studies, which were initiated by Georges Deicha (1917-2011) in Paris. Materials from Liechtenstein illustrated the reference book on that matter as early as 1955. [17]

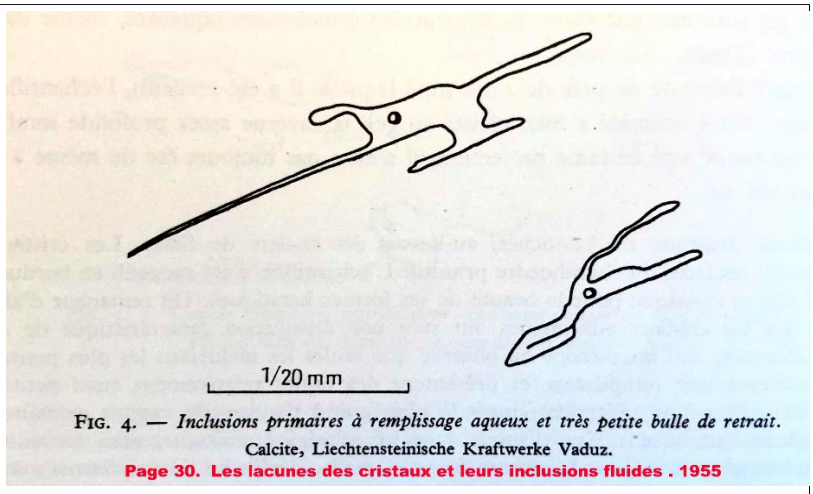


FIG. 4. — *Inclusions primaires à remplissage aqueux et très petite bulle de retrait.* Calcite, Liechtensteinische Kraftwerke Vaduz.

Page 30. Les lacunes des cristaux et leurs inclusions fluides . 1955

The geographic studies are also often regional [18]

-3- Outreach

In the general public the interest of geosciences is almost always associated with domestic geography, archaeology, mountain sports, or environmental concerns.

Geology as a science was poorly represented in previous years. For instance in museums there are very few ehibits. In the school curricula basics

17 DEICHA (G.) - Les lacunes des cristaux et leurs inclusions fluides, signification dans la genèse des gîtes minéraux et des roches. 126 p., Masson & Cie, Paris, (1955).

18 Rougier H , Deicha I. . Au coeur des Alpes, un état pas comme les autres, (Annales de Géographie t.97; n°540; 1988 pp. 129-149)

in geology did not appear as an own scientific matter, but together with geographical or environmental items.

Nowadays we can say that there is a trend to develop seriously scientific knowledge, and geosciences are in progress. In the last decades geology was the theme of several installations in the public space in Malbun [19] also in Bendern ("Stone Path") or around a fountain in Vaduz (each rock comes from one of the villages in the neigbourhood)

[20]

C- Institutional Actors

-1- Associations

Interested persons meet and publish in different generalist associations, who edit bulletins, also with contributions about earth sciences. Let's cite three of them, devoted to history, to alpinism and to science.

Historischer Verein (HVFL)[21] is the historical association of the country, one of the oldest learned societies, landowner of some historical sites and editor of an annual bulletin "J*ahrbuch des Historischen Vereins*" (The first studies „Liechtenstein's Geology " were issued there in 1951 and 1952).

Liechtensteiner Alpenverein (LAV)[22] is the national mounaineering club, member of the international network "Arc Alpin" , landowner of two mountain huts and editor of a quarterly bulletin "*Enzian*" and an annual report "*Bergheimat*", LAV Is the editor of the reference book "*Geologie Liechtensteins*" by Daniel Miescher.

19 The agency *Liechtenstein Tourismus* reconmmends the geological trail in the alpine resort Malbun: https://www.outdooractive.com/de/route/themenweg/liechtenstein/geologiepfad-malbun/61853184/

20 Photo C. Deicha 2022

21 www.historischerverein.li

22 . www.alpenverein.li

Naturwissenschaftliches Forum (NWF)[23] is the Liechtenstein Scientific Society, for science outreach, and relations to international academic organizations (EPS, IAU, ECROFI, INHIGEO). NWF is the editor of the latest bibliography on history of geosciences [24]

-2- Collections

« Scientific collections and museums are usually associated with research institutions or carry out the research themselves. However, Liechtenstein does not have its own institute or higher education institution for natural science disciplines. For this reason, the natural history research of the country before 1970 was limited to more or less accidental works? » as explained in the catalogue of the Landesmuseum. [25]

There are also regional collections not limited by the boundaries of the Principality. Private collections can be preserved if the family takes care of them [26]
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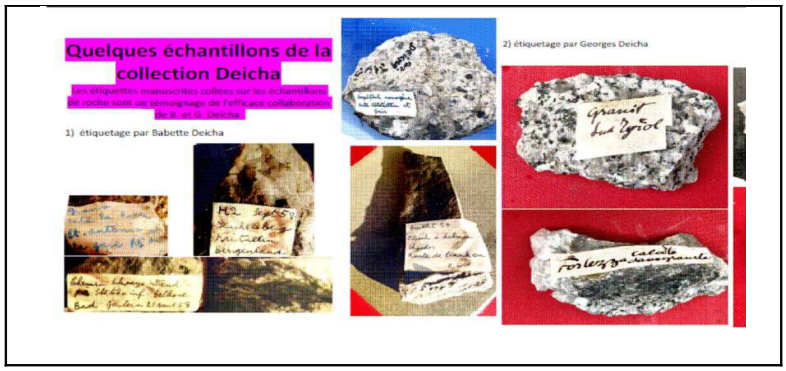


In Vaduz, the *Landesmuseum* principally devoted to the local history and archaeology has a small geological exhibition (nine polished blocks used as seatings for visitors, three fossils and a table alowing visitors to touch various stones... not even all of local origin !).

-3- Governmental actors .

23 https://dachverband.li/naturwissenschaftliches-forum

24 Deicha C.; "Contribution à l'histoire des géosciences au Liechtenstein, essai de compilation bibliographique". Naturwissenschaftliches Forum Vaduz Mars 2022 online : https://dachverband.li/application/files/8716/4685/4431/2022GeosciencesLiech.pdf

25 . www.landesmuseum.li

26 The collection of late Georges Deicha was described recently by his daughter (Deicha S. "Vers la contemplation des phénomènes" NWF 2019) online : https://cite.monsite-orange.fr/file/8eeea369e576d1bb5985ab04e8691415.pdf

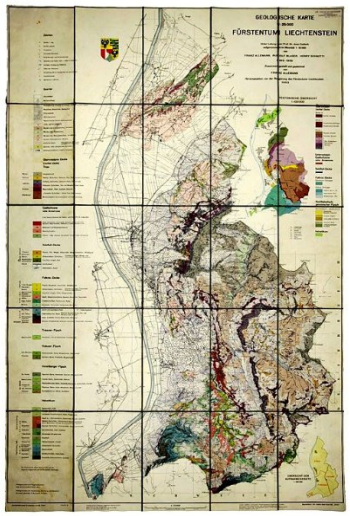
In another showroom of the Museum there is a sample of lunar rock. It is probably the only one in Europe and for this it is very popular among tourists, but infortunately it is not accessible to scientists, because it is encapsulated in a glass sphere !

There are only 70 geological samples in "*Naturkundliche Sammlungen (Amt für Umwelt*)" . We notice that there are fare more numerous artefacts from Zoology and Botanics than Geology.

The Liechtenstein Government also operates an archaeological service (Amt für Kultur) who has a certain legal control of the heritage of hidden treasures in the soil , and their scientifically correct handling [27]

A geological map was realized by Franz Alemann in the fifties and is currently re-edited by the government : "*Geologische Karte Liechtensteins*" [28]

All literature is available at the National Library (Landesbibliothek)[29]



-C- Comparison with the neighbours

Geosciences beyond boundaries

The country is inbedded in a regional Landscape that includes the swiss cantons St Gallen and Grisons in the South and West, and the Austrian federal Land Vorarlberg in the North and East . They form together a coherent region of the German-speaking cultural space with strong ties to cities with
Universities and Institutes (Innsbruck, Zürich), over-regional specialized learned societies (Geological Societies , Mineralogical Societies, Geographical Societies), there are enough readers for scientific editors

27 Site of the administration *(Landesverwaltung):* www.llv.li

28 Allemann, F. (1985). *Geologische Karte des Fürstentums Liechtenstein, 1 : 25'000* ; Regierung des Fürstentums Liechtenstein Hrsg. Vaduz .
Link : https://www.google.com/imgres?imgurl=https://historisches-lexikon.li/images/thumb/b/b1/Geologie_Uebersicht100-2.jpg/300px-Geologie_Uebersicht100-2.jpg&imgrefurl=https://historisches-lexikon.li/Geologie&docid=dpaxh6hcgyLtbM&tbnid=GnCKpOZztp_BOM&vet=1&w=300&h=399&hl=de&source=sh/x/im

29 Site of the National Library .www.landesbibliothek.li

The Principality of Liechtenstein belongs to the eight “Alpine countries”, and is member of the Alpine Treaty Convention

30

Most of the field activity (investigations of geologists or geographers , as well as paedagogic excursions of schoolclasses etc) ignore the national boundaries, especially to the two neighbours: Austria and Swizerland

-Austria

The Geological Map of Vorarlberg includes also Liechtenstein, whose upper tectonic layers are an extension of the austrian ostalpin. Most regional books and publications and also the Association of Vorarlberg Friends of Nature deal with this subject.[31]

Switzerland

The *UNESCO-heritage Tektonik arena Sardona* begins only few kilometers South-west from the Swiss-Liechtenstein frontier. This large national park (twice the area of Liechtenstein) is a vivid museum of the alpine geological history .[32]

“This Region is unique in the world: nowhere else are the results of the processes that led to the formation of mountains as evident as they are here.”

30 About the Alpine Convention: https://www.alpenverein.at/portal/natur-umwelt/av-naturschutz/alpenkonvention/liste-ak/01_geschichte-ak.php

31 Austrian association of friends of nature/ https://vorarlberg.naturfreunde.at/

32 Swiss UNESCO-heritage : www.unesco-sardona.ch