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Alignments of orchids possibly indicating the presence of fault intersections – review of the GIS data, the uncertainties, the statistics behind each lineament and the corroboration by deep seated earthquakes

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Summary

The current work is a very small and tentative step to see if some occurrences of orchids could help understand better the shallow subsurface. Accepting the concept may be challenging but here it is.

The increased use of GPS and GIS databases has made a questionable observation suddenly testable: the link between alignments of cold climate orchids and faults; something that has been known for a long time but never proven. The present work wants to set the scene for future investigative work on the matter; if proven correct that may have huge implications for shallow and deep subsurface understanding and more particularly for hydrogeology.

Orchids records and locations have been taken from two GIS databases: the iNaturalist database for which photos are collected and cross-referenced and the GBIF database that has much more data as well as historical data but no photos. The uncertainty on the data is less on the correct identification of the orchid species than on the positioning on the map; the problem of the latter will be summarized with a variety of GBIF examples including orchids plotted in lakes (e.g. Parentis in France) or in the Indian Ocean (West of Perth).

Observations are most often taken along or very close to trails and roads, making any trend questionable. Evidence of long straight of roads, trails or rivers controlled by faults will be discussed with examples including earthquakes lineaments. No attempt should be made of finding orchid alignments when dealing with clusters.

The presence of orchids is most often sporadic along any recognized alignment; this is reminiscent of patterns shown by earthquakes. In both cases, this is interpreted as fault intersections, to create the resistance to motion in the case of earthquakes and to create open fractures and fluid flow in the case of orchids. Examples of fault intersections will be shown on earthquakes and orchids maps.

The existence of open fractures and that of intersections of faults are conceptual and guided by the need for the presence of healthy mycorrhizal fungi to allow the growth of orchids. For the needy fungi, open fractures would be the conduits bringing essential key nutrients such as nitrogen.

Introduction

A geological field trip in quarries exploiting the Frasnian reefs of Ferques (Northern France) was for me a remarkable introduction to the link between faults, dolomitization and orchids as well as a first experience with H2S filled dolomite (Fig.1); the alignment of several Ophrys apifera was observed on a meadow between two quarries; today, the meadow is no more and the observation is just a distant memory.

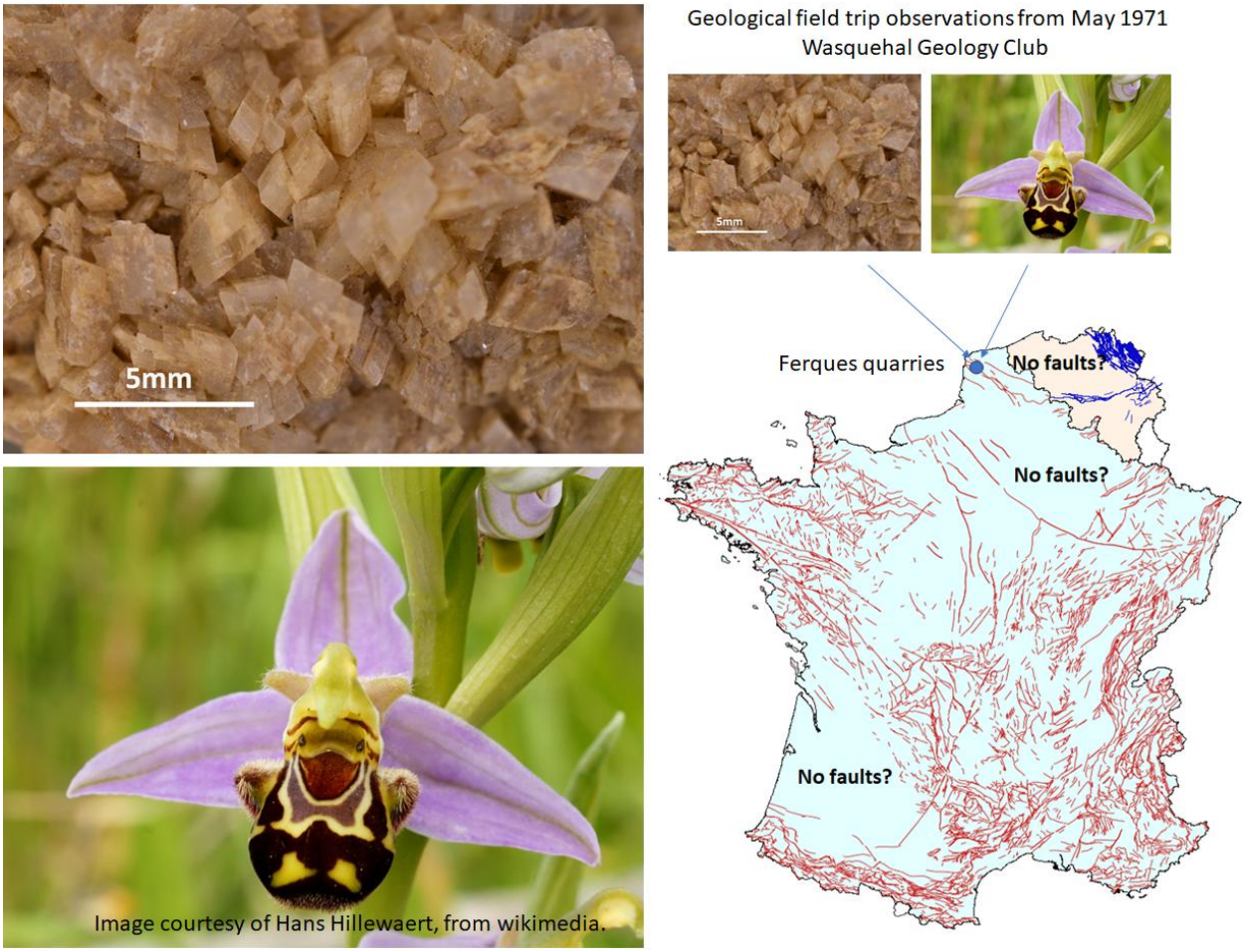


Fig 1 What was known long time ago and since forgotten – linear organization of orchids (Ophrys apifera) associated with dolomitization along a fault mapped by Dr J-P Colbeaux – blue dot is the location of the aligned orchids first seen by the author – the shown dolomite sample was collected along the orchid alignment during the 1971 excursion.

Recently, the availability of GPS on smartphones, GIS software and online databases delivers an opportunity to test the validity of the link between orchid and faults, hence this paper.

Documentation problem and GIS solution

Orchids in cold climate regions only have flowers during a rather short period of time (e.g. mid-May to mid-June) and orchids are not easy to spot and identify without the flower. The problem is that no single individual or small group of people would be able to have enough information to prove or disprove the existence of a link between orchids and faults.

The solution came with newly available GPS and GIS software and online databases such as iNaturalist and GBIF. In the last five years or so, scientists have started to populate such databases; this is just the very beginning as more people will make observations and report them.

Uncertainties

The uncertainty on the data available in iNaturalist and GBIG is less on the correct identification of the orchid species than on the positioning on the map.

Observations about plants are most often taken along or very close to trails and roads, making any trend questionable. Evidence of long straight of roads, trails or rivers controlled by faults are common; thus, perfect alignments of earthquakes can be interpreted as vertical faults and earthquakes lineaments are sometimes parallel to very long straights of roads (Fig.2).

Orchids records and locations have been taken from two GIS databases: the iNaturalist for which photos are collected and cross-referenced and the GBIF that has much more data as well as historical data but without photos nor cross-references that I know of. The maps on Figure 3 shows the bias recording of orchids along major trails and roads as well the problematic locations (orchids in lakes); there are more than 50 orchids reported in the Ocean west of Perth (Australia) in the GBIF database. The main observed problem is with the longitude and older GPS devices when the wrong datum is used; some trends may have to be discarded as artifacts in large areas (Fig.4).

Another factor to keep in mind is that there are places with clusters as well as extremely large areas with no data. Two of the most important parameters to be considered are parallelism of a few lineaments and the width of the zone between successive lineaments.

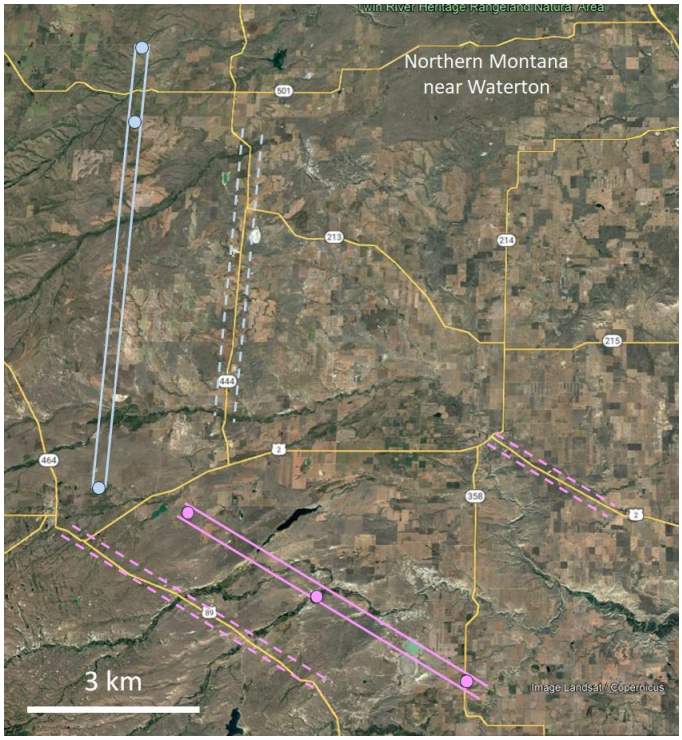


Fig.2 Example of long straight of roads likely controlled by vertical faults because apparently parallel to deep seated earthquake lineaments (blue and pink filled circles)– average altitude of the area is 1250m – map from Google Earth

Figure 5 is taken from the area of my childhood; an area I know well. On the map one can see many orchids arranged in a well-defined corridor that locally controls the river Lys; to the east of the corridor, a fault limits the Northern part of a quarry dug in Eocene silts and clays. Note that several orchid alignments have the same orientation.

Of interest is the NW-SE orchid alignment oblique to the major lineament; it is made of four recorded occurrences of orchids, two of which also pertain to other alignments. Orchids are most likely present at intersection of faults, a subject to be discussed later. The cross-section from Google Earth clearly shows the importance of the fault associated with the orchid corridor.

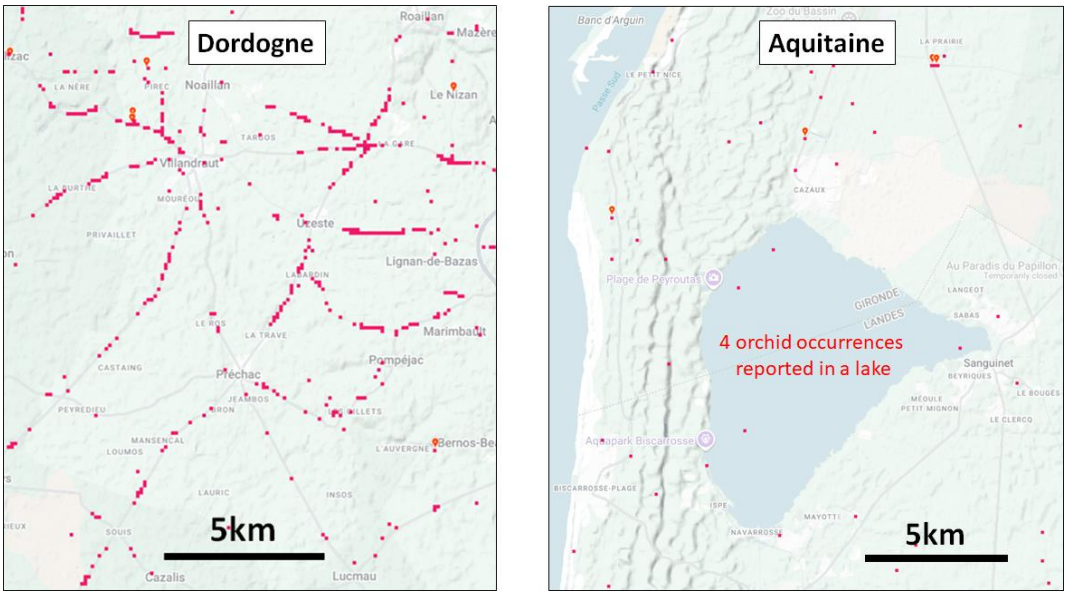


Fig 3 Some problems of usability of the data; map on the left shows a very strong bias of observation along paths and roads; the map on the right shows orchids within Lake Parentis (France) - Map data ©2025 Google

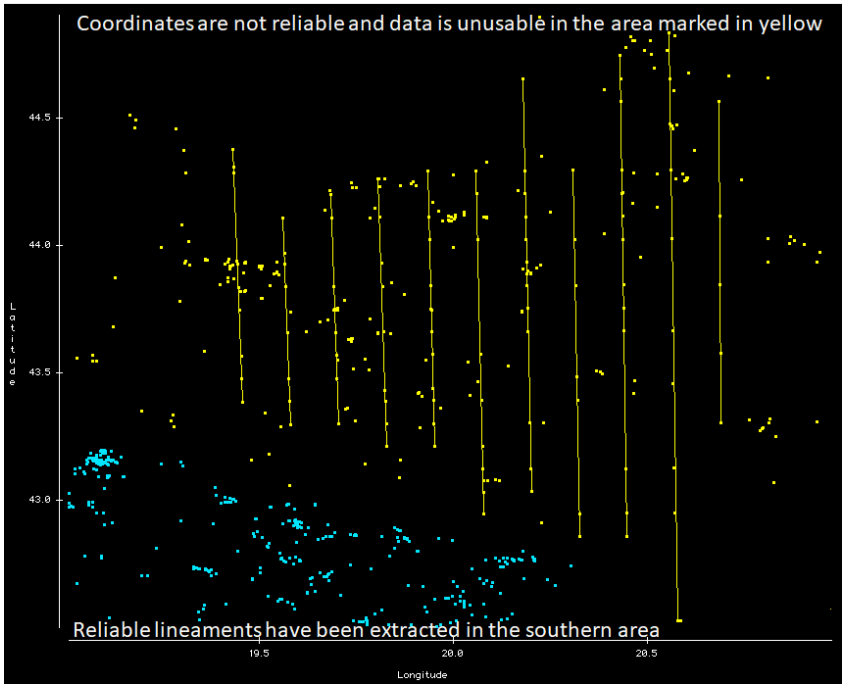


Fig.4 Alignments of orchids in a large part of an area in Serbia studied by Djordjecic et al, 2024 are deemed unreliable – the area in blue is thought to be without artifacts and usable for trend analysis

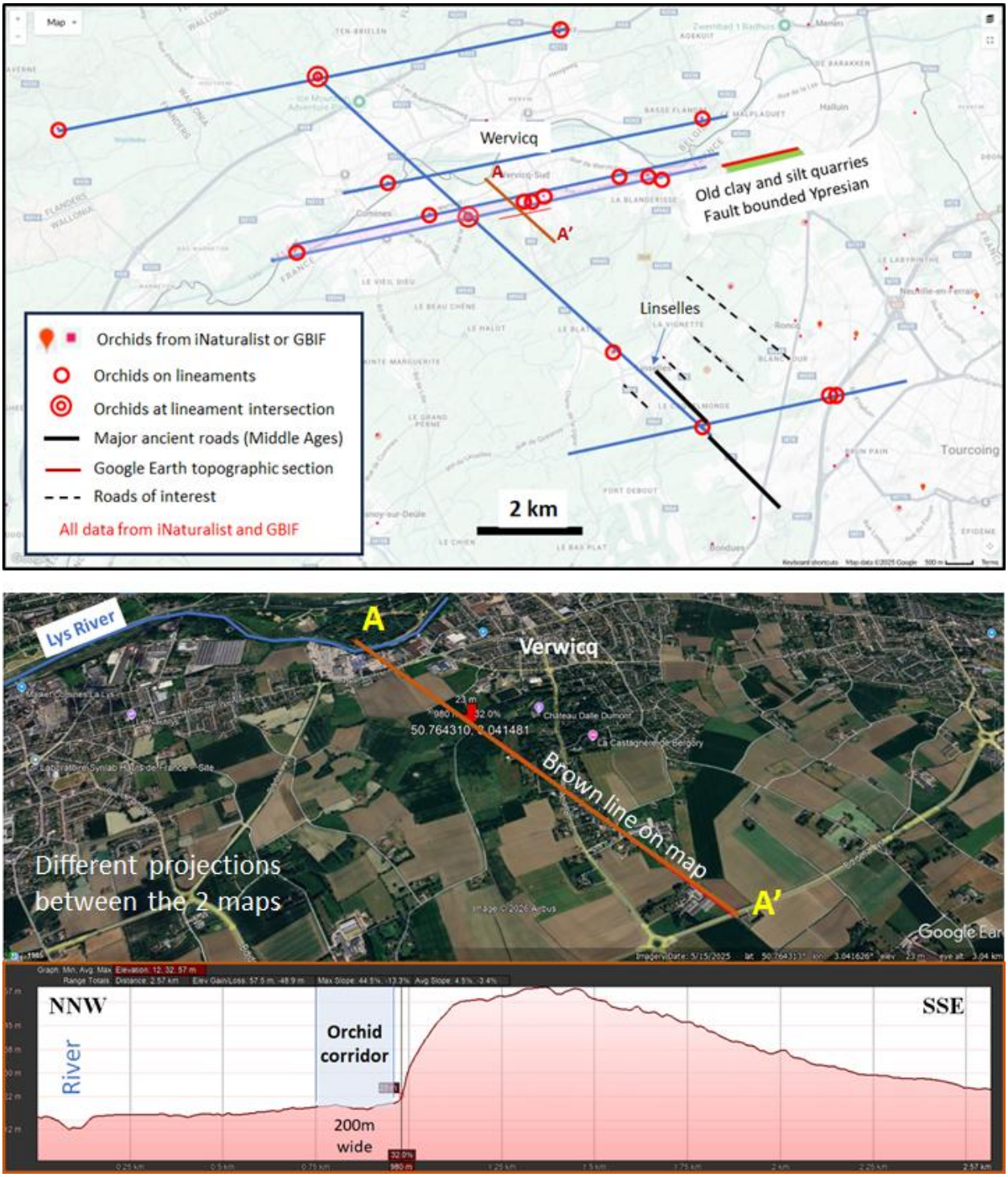


Fig.5 Example (from Northern France) of orchids aligned and associated to faults with two records of orchids at intersection of faults – fault south of the orchid corridor is well expressed in the topography – Top map (Map data ©2025 Google); Bottom map from Google Earth

Selected orchid alignments in Alberta and Eastern B.C.

In areas with little data any interpretation may be proposed but need some back-up by some other observations. Thus, one orchids alignment near Chip Lake is probably real as it is exactly parallel to the only straight on the lake and parallel to the only orchid derived lineament from neighbouring Fox Creek area (Fig.6). The orientation of the alignment is perfectly perpendicular to the calculated Alberta major extension orientation (Chatellier 2024). Note that in cases of major faults, the orchids may be linearly oriented forming corridors, the largest one measured in this study was in Eastern British Columbia and was about 100 m wide.

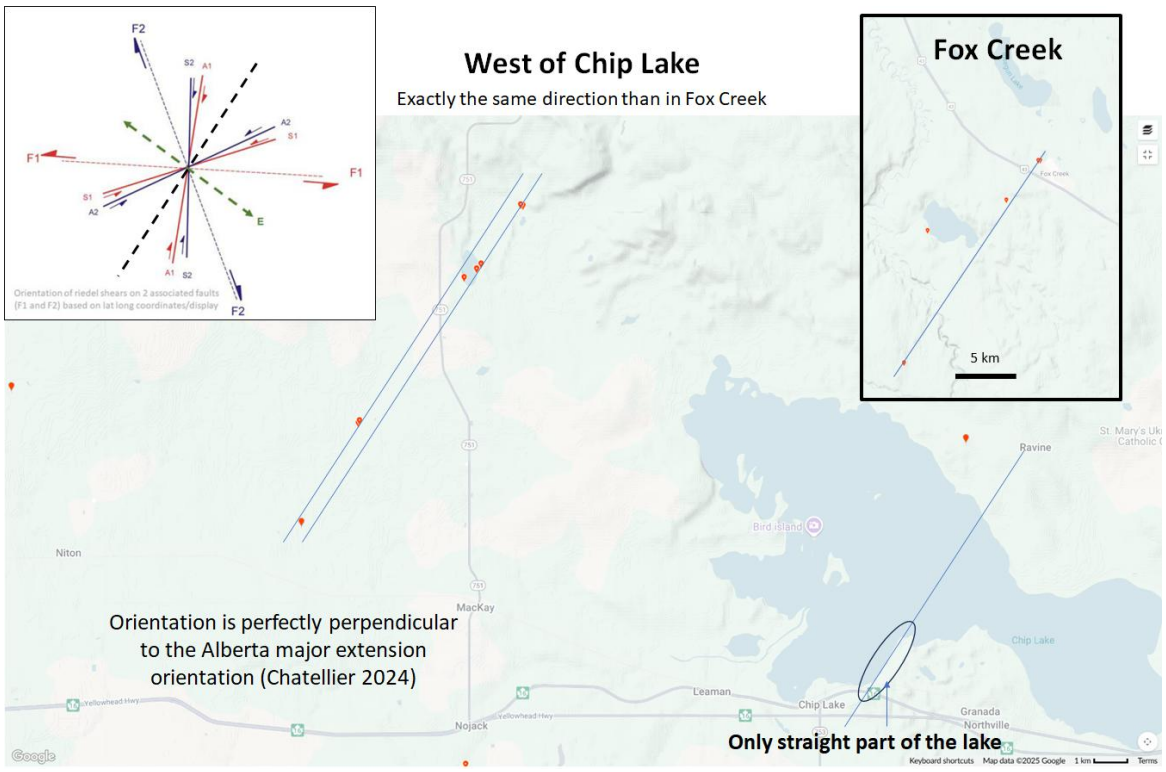


Fig 6 Orchid lineaments West of Chip Lake and in Fox Creek corroborated by one linear part of Chip lake – the orientation is very meaningful in terms of regional geology - Map data ©2025 Google

The density of the collected data varies a lot and the distribution of orchids is even more varied but alignments are found. Figure 7 compares around Arbour Lake in NW Calgary all of the data recorded in the GBIF database (top left) and three recognized alignments that are with the same orientation. On the righthand side of figure 7 the correlation coefficients of each alignment is shown; alignments 1 and 2 are absolutely parallel to each other (see reported coefficients).

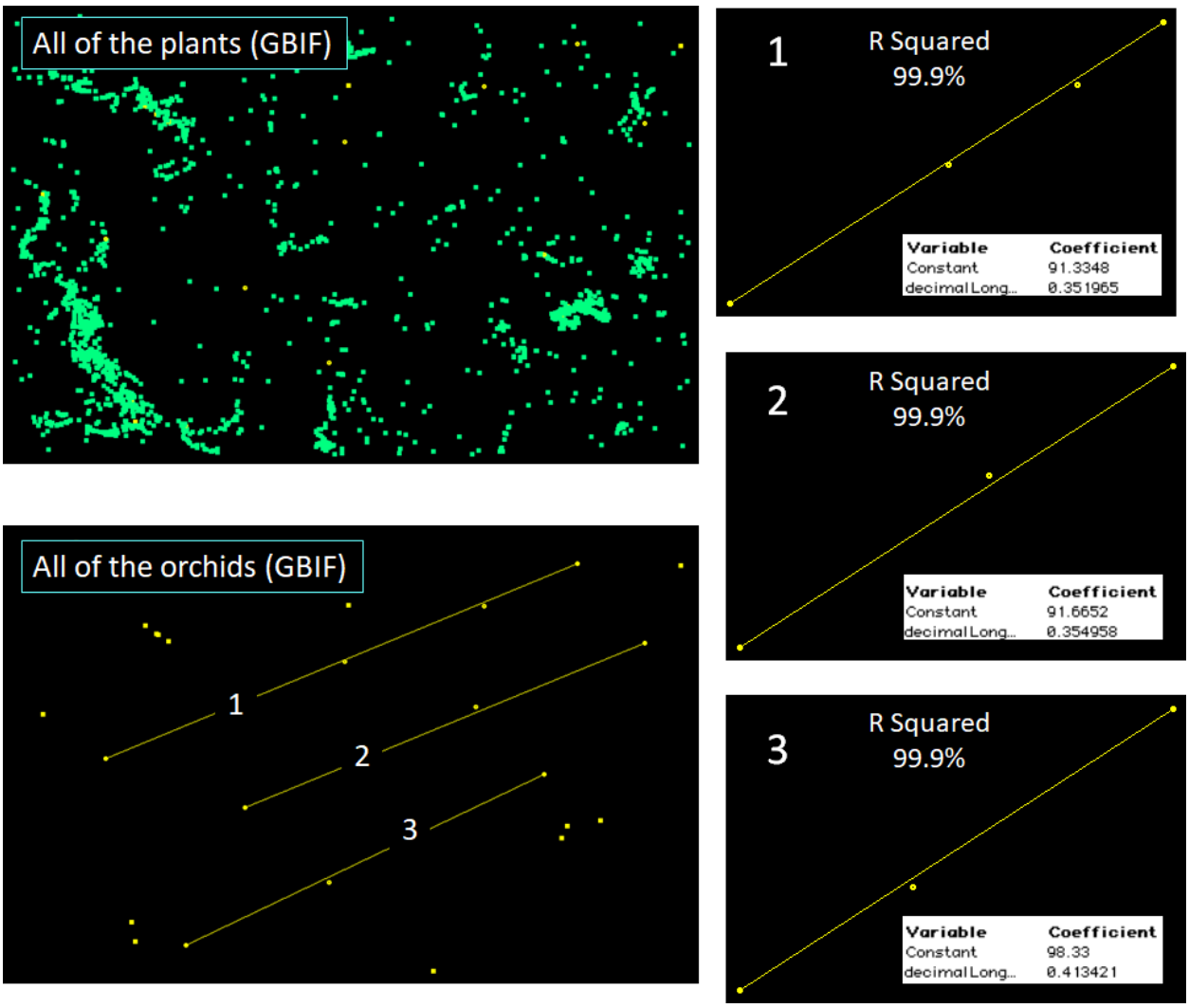


Fig.7 A view of all of the reported plants in the area of Greater Arbour Lake (top left) and all of the orchids (bottom left); the statistics for each alignment on the right – the total absence of orchids between the three alignments is the second most important Quality Control factor after the correlation coefficient which is 99.9% for each alignment

The map corresponding to the same data set is displayed in the bottom right corner of figure 8. In the area of interest only five different species of orchids have been found along the alignments; photos have been compiled on figure 9. The orchids lineaments around Arbour Lake are compared to earthquake lineaments based on earthquakes since 2006 marked in red in the two Google Earth images.

One can see the near perfect parallelism between the two earthquake lineaments and the orchids alignments. The northern earthquake lineament comprising 4 earthquakes with a 99.9% R squared extend to the west to the Southern linear limit of Barrier Lake. Major structural "breaks" South of Barrier Lake have the same orientation as both earthquake lineaments which corresponds to deep seated vertical faults.

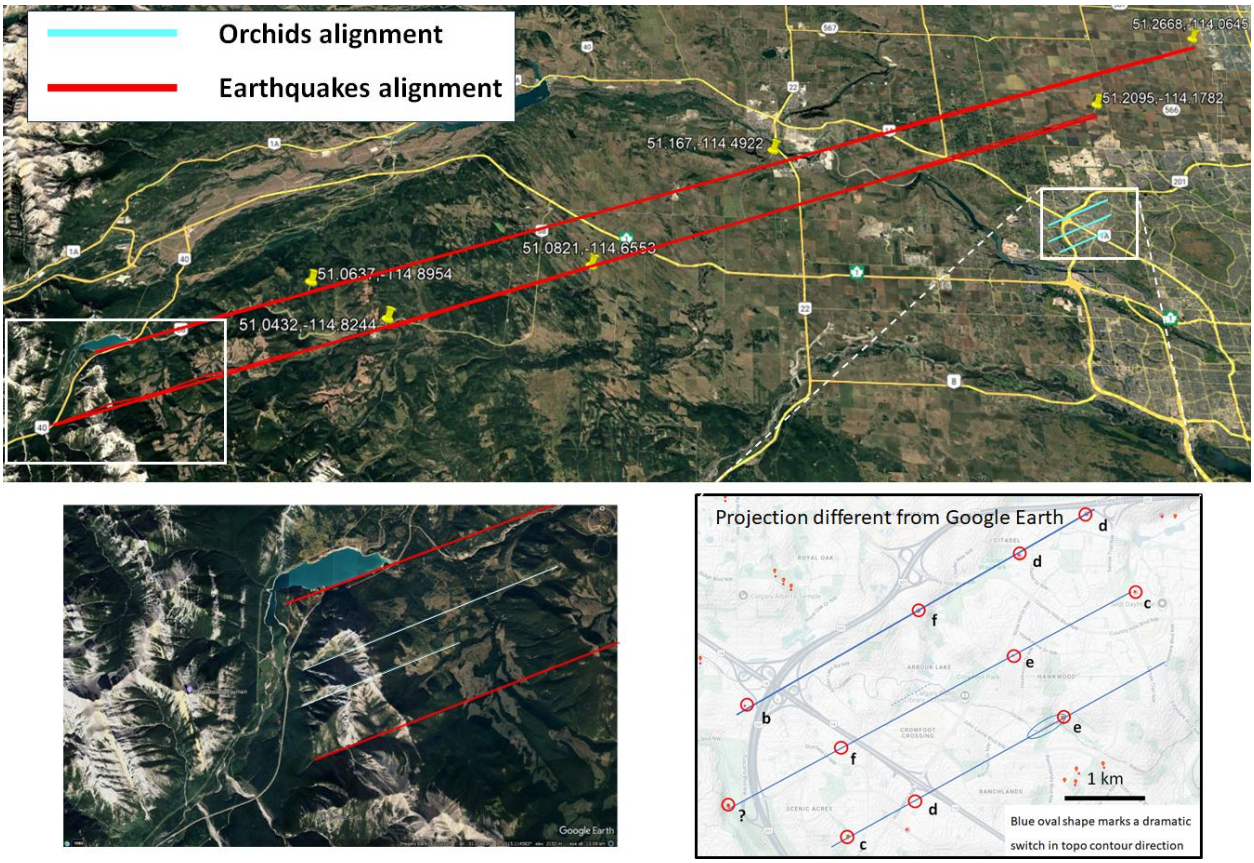


Fig.8 Alignments of orchids based on GBIF data and alignments of earthquakes based on occurrences since 2006 – features such as the Barrier lake southern boundary complement the overall picture – the letters on the map correspond to the orchid species reported on Fig. 9. Copyright Google Earth and Map data ©2025 Google

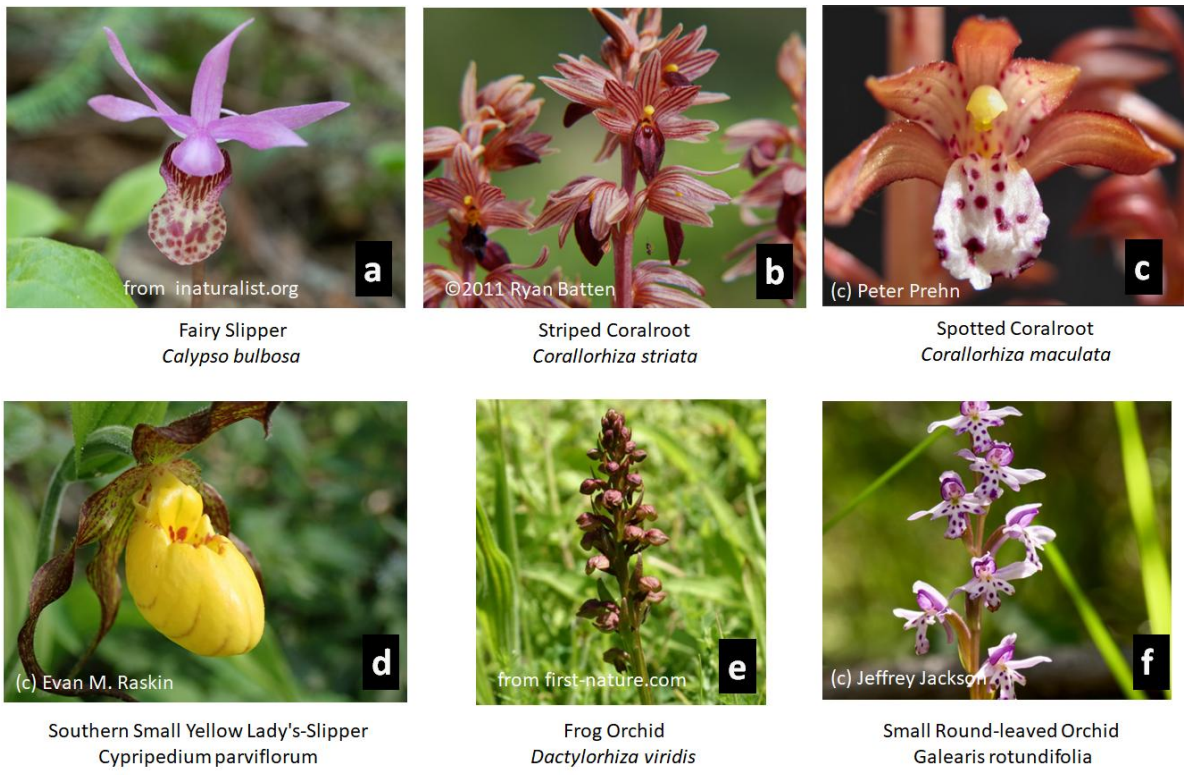


Fig.9 Photos of orchid species associated with the recognized/proposed fault related alignments around Radium Hot Springs (a, b, c) and near Arbour Lake (b, c, d, e, f)

Another area of interest is around Radium Hot Springs (Fig,10). The database has a large amount of collected data but only 6 orchids aligned on two lineaments. The SW-NE alignment is perfectly parallel to a long straight of road indicated on the map. Additionally, one of the orchids is at the intersection of two the two alignments; this is reminiscent of what we saw in the Northen France example (Fig.5) and what will be shown later in the Kananaskis example and some earthquake map.

The Kananaskis example (Fig.11) combines a few of the observations mentioned earlier and more. Thus, alignment C is long and is strictly along a linear trail that appears to be a fault – it is the only long straight boundary between two geological formations. Alignments A and B are parallel to each other and slightly offset along a possible fault that would be expressed by the West Wind Creek which is perfectly parallel to alignment C.

As seen before in previous examples, there is one orchid sighting that is at the intersection between two alignments (A and C); that was already the case in figs 5 and 10.

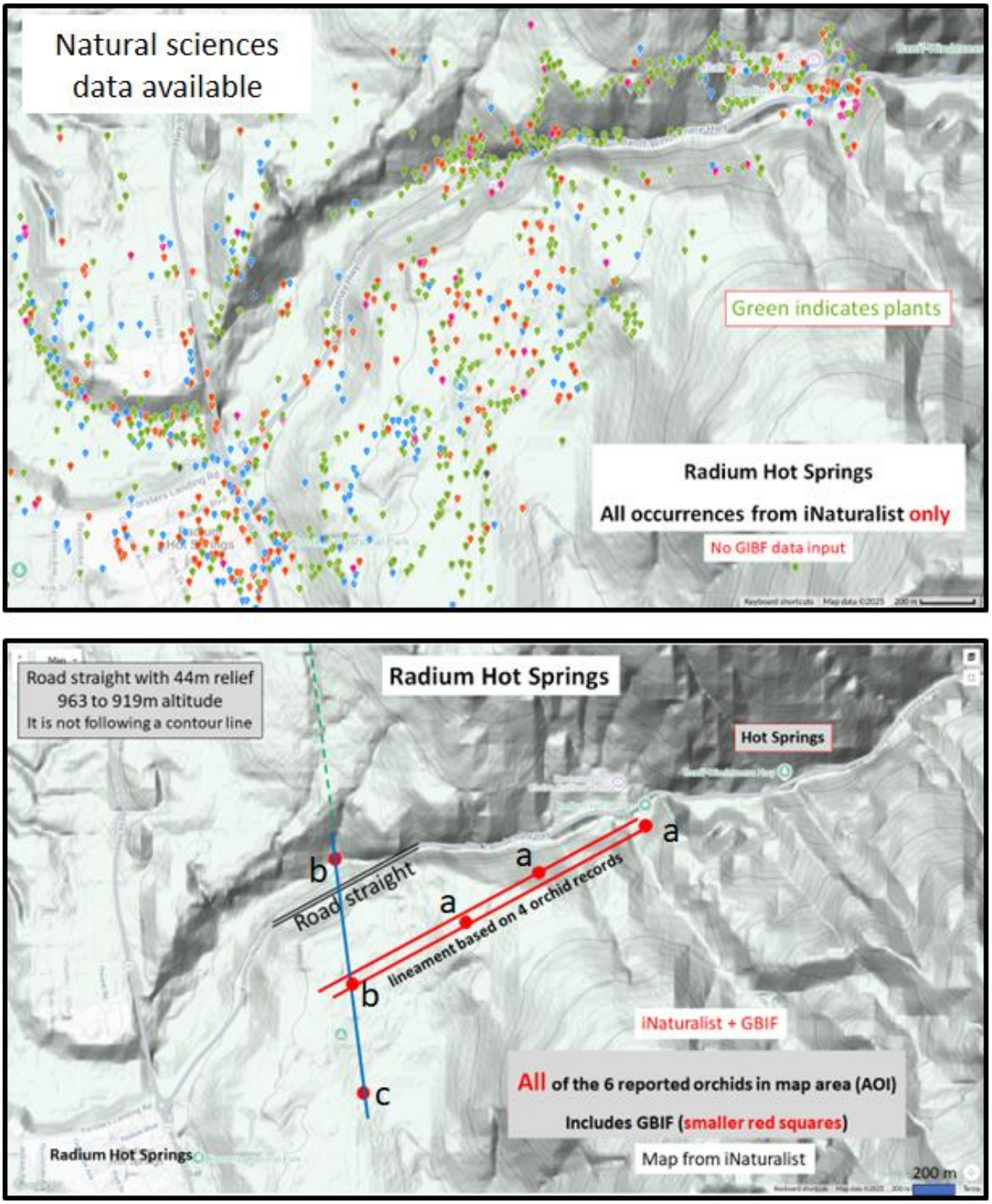
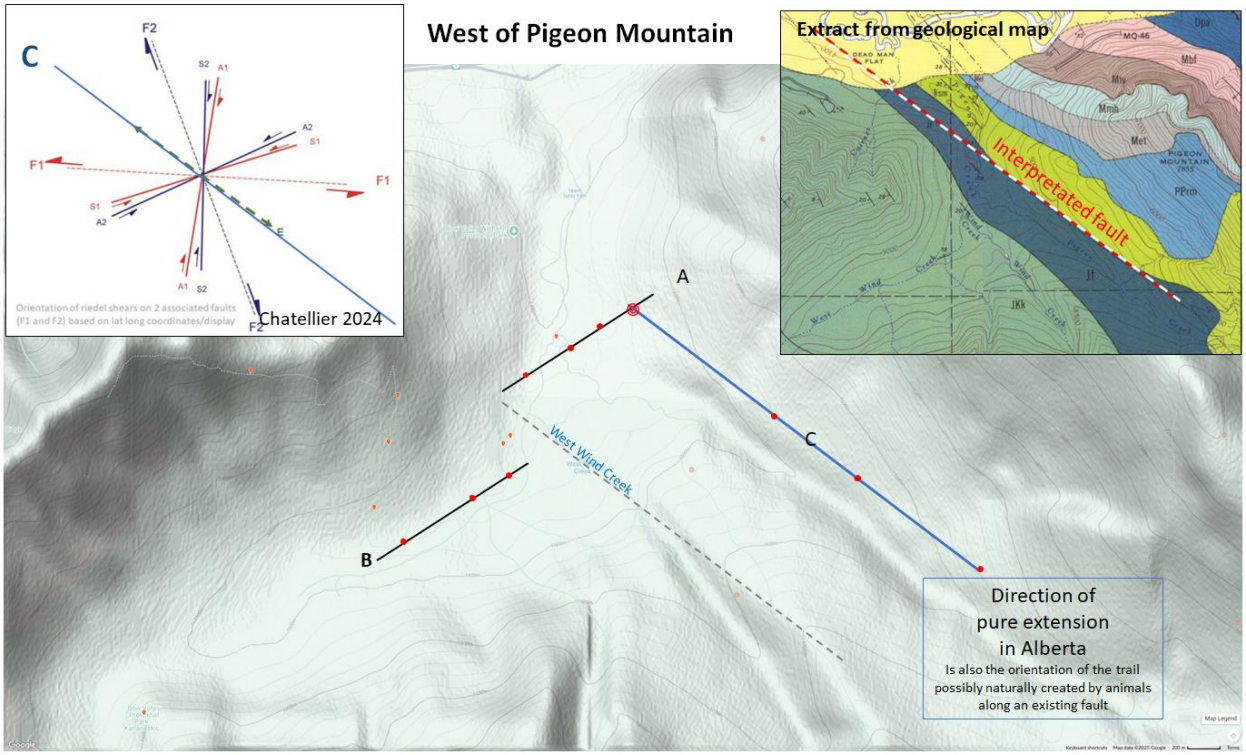


Fig. 10 Animal and plant data in the area around Radium Hot Springs (top image) and all of the reported occurrences of orchids from the iNaturalist and GBIF databases clearly showing two alignments (bottom) – note that one orchid has been reported at the intersection between the two alignments - Map data ©2025 Google – top map: Blue = animals, red =insects, pink =fungi



Recognition of two parallel lineaments based on orchids observations (A and B - 4 and 3 verified occurrences); the long orchid-based C lineament with 4 occurrences is parallel to the West Wind Creek and corresponds to a very linear trail crossing the contour lines; this is probably a path created by animals along a fault - Note one orchid reported at the intersection between two lineaments (faults).

Fig.11 Three alignments of orchids interpreted as faults and one occurrence of orchid located at the intersection of two faults - Map data ©2025 Google

Learning from earthquakes alignments

Let us look at some areas that have no to very little orchids and no alignments to speak of. The chosen West Central Alberta example (Fig. 12) is perfect to help understand deep seated faults because of the presence of a carbonate platform that fix better the various overlying formations.

Three sets of lineaments have been recognized based on many types of observations, one of them being earthquakes; all earthquakes are pre-2006. One of the earthquakes is exactly at the intersection between lineaments C and F, giving credit once more to the hypothesis that earthquakes occur at the crossing of faults.

Several lineaments are observed parallel to lineament F which is oriented North 9° and corresponds to the antithetic Riedel shear of the sinistral strike slip fault oriented N98.6° (UTM). Swarms of open fractures associated with lineament G have created extremely productive wells (stars on the map) in Leduc, Wabamun and Belly River that saw large water influx because of excessive and optimistic production rates. The dark blue circles mark the presence of unexpected Mississippian oil shows indicating a migration path along the lineament. To the right of Lineament G a very long linear stretch of a river indicates a control by fault. The last feature indicating a structural control is the linear eastern part of the carbonate platform still oriented N9°.

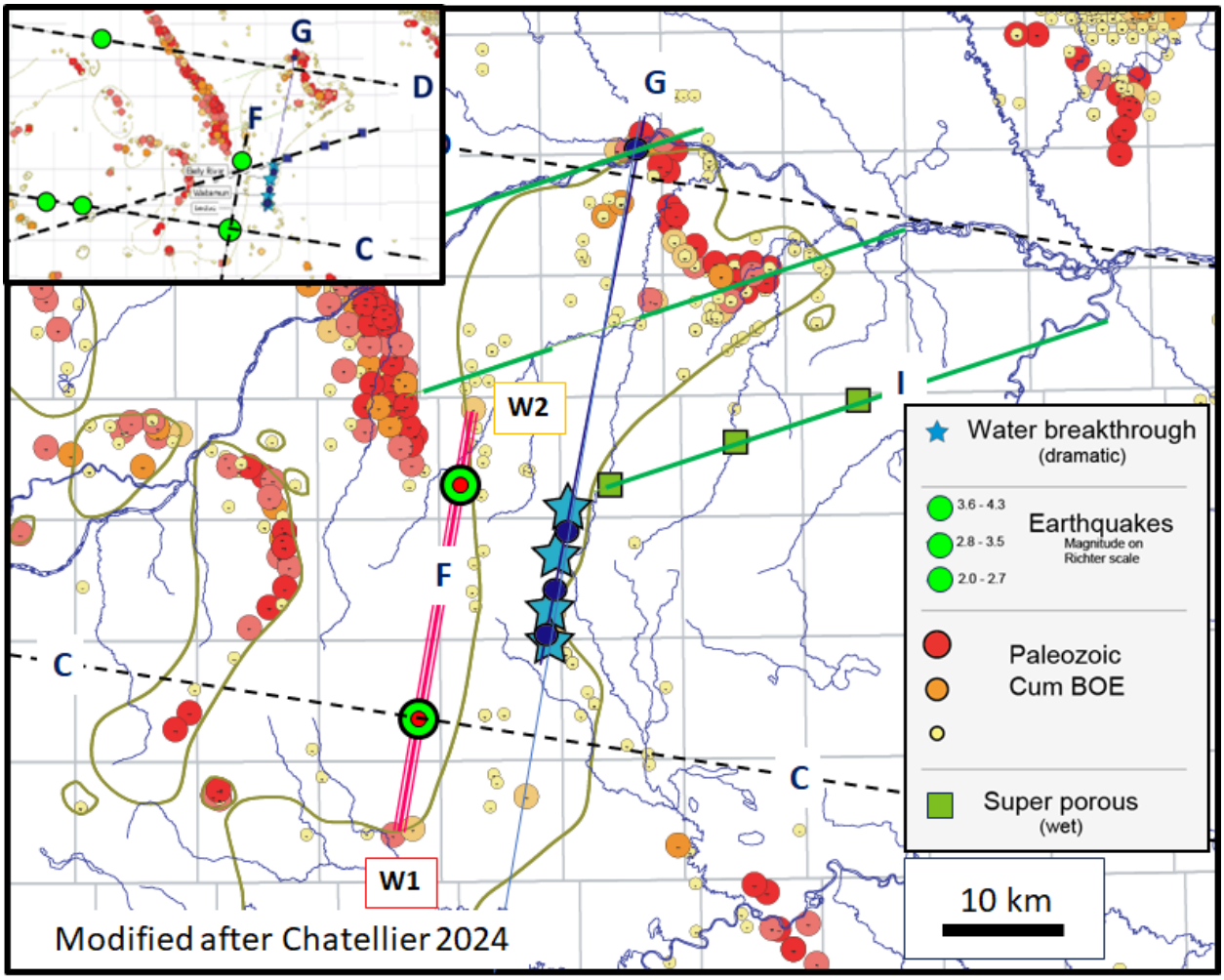


Fig.12 Map of West Central Alberta South-West of Whitecourt used to show an earthquake at the intersection of two deep seated faults marked as C and F (map and insert}. Note the There

There is parallelism between the deap seated F lineament, the subsurface G lineament and the shallow lineament expressed by the river East of lineament G among others.

Three points in 3-D always make a plane, a fourth point is needed for confirmation of the existence of a meaningful plane; on the othe hand, 3 aligned points on a map are indicative of a vertical or near vertical plane; this is true for earthquakes as it is for orchids.

Figure 13 covering a large area of West Central Alberta demomstrate that two earthquakes can be proposed to be on an alignement when the direction is in perfect agreement with other well defined ones. Lineament D is proposed on the basis of one single earthquake as it coincides with a several township long straight of river (see Fig.12). Similarly, Lineament H made up of three earthquakes (yellow) coincides with an alignement of anomalously very porous wells (dark blue). As for the various orchids examples, the very large space without any earthquakes between alignements has to be taken into account in an interpretation.

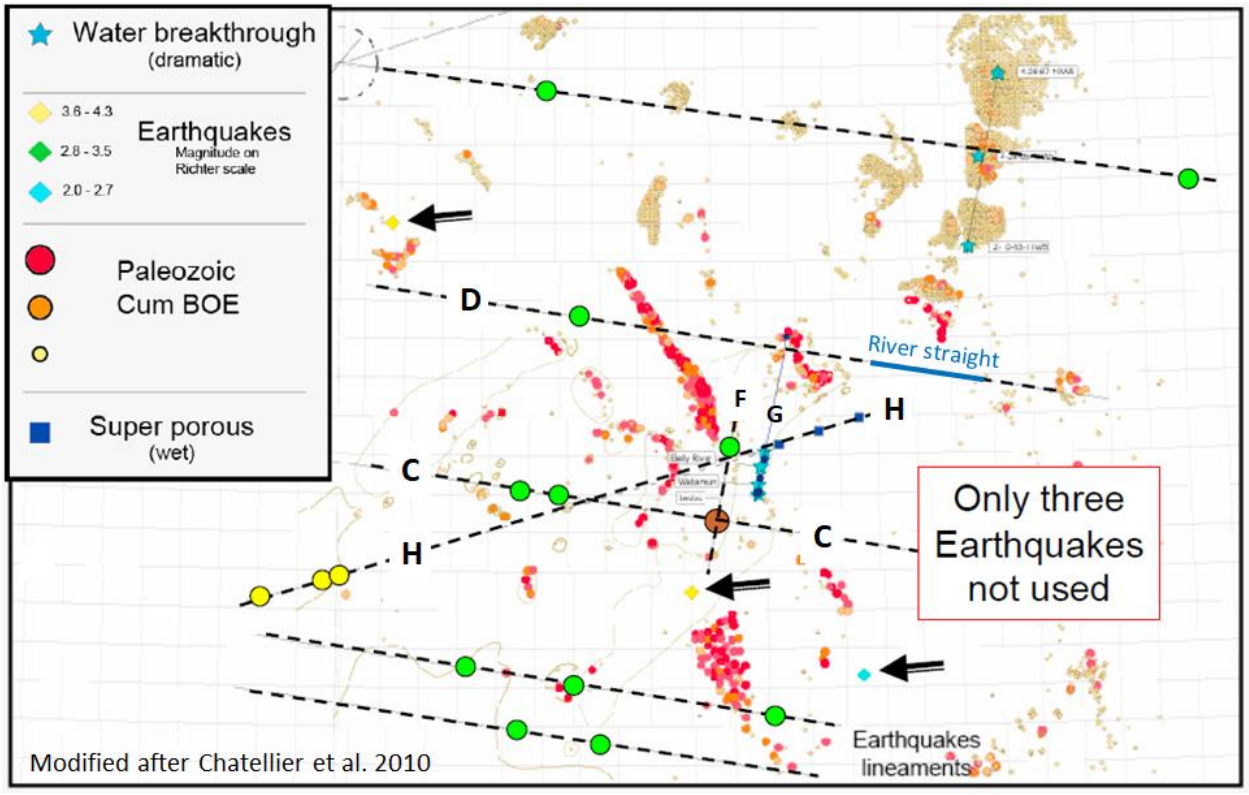


Fig.13 Overview of earthquake alignments in West Central Alberta.

Quality control of alignments

Many scientists may doubt of the validity of some alignments as well as their link to existing faults. This is why the correlation coefficient is calculated for every lineament, keeping only alignments when R Squared is equal to 0.98, 0.99 and 1.00. The width of the empty space between alignments/lineaments needs to be systematically taken into account.

It is very important to keep in mind that any point can belong to two lineaments (Chatellier, 1992), and three in case of triple junction; additionally, two points can be sometimes making a lineament when spacing between lineaments is identical (Chatellier et al., 2010).

Earthquakes are sporadically distributed along a lineament, just as orchids are (in most cases); the proposed hypothetical interpretation in both cases is that we are dealing with fault intersections.

A note on the biological kink: Fungi

Orchids are rather rare in cold climates as they require ideal soil conditions and the presence of mycorrhizal fungi. Additionally, most orchids rely on specific insects or animals to transfer pollen.

Most orchids thrive in a slightly acidic to neutral environment, typically around pH 5.5 – 6.5. Such a pH range allows for maximum availability of key nutrients (N, P, K, Ca, Mg, Fe, Mn) and a healthy activity of mycorrhizal fungi

Mycorrhizal fungi form a symbiotic, mutually beneficial relationship with orchid roots, extending the root system to vastly increase water and nutrient (like phosphorus, nitrogen) absorption in exchange for sugars from the plant, boosting orchid health, growth, and resilience while creating vast underground fungal networks that connect plants. These microscopic fungi, are crucial for soil health, improving structure, and protecting against stress. They are vital to orchid growth.

Potential follow- up

The link between orchids and fault intersections is a working hypothesis. The ground where the orchids are growing should have characteristics different from the surrounding grounds. Thus, it is expected that there would be differences in major ion chemistry, temperature, hygrometry, and hydraulic conductivity.

Mapping surface expressions of lineaments and checking fracture density along them could confirm or contradict the hypothesis of orchids at fault intersections. Understanding these orchid

lineaments could be important for hydrogeology because fracture zones can influence permeability and groundwater/contaminant movement.

Existence of Mycorrhizal fungi near orchids needs to be confirmed and their absence in neighboring grounds should also be assessed.

The distribution of isolated orchids could be ideal to be analyzed using Artificial Intelligence and extract meaningful orchids alignments.

Conclusions

Orchid alignments have been observed all over the world. A link to faults and more particularly fault intersections is tentatively proposed based on a series of examples using iNaturalist and GBIF online databases and maps.

Open fractures associated to faults intersections are thought to provide the conduits for bringing gasses and nutrients needed by Mycorrhiza fungi which are essential to orchids.

A review of earthquake lineaments corroborates the link between orchids and faults.

If the link between orchids and faults is proven correct, this would offer a new tool to a first pass structural analysis in some areas where no seismic is available.

The available online databases are rapidly getting populated, offering an ever-improving tool.

Much is still to be done as this is just food for thought.

As a final point, and to come back to Northern France where everything started, figure 14 shows a perfect parallelism between an orchid lineament, a straight of road and a well-defined fault (Carte Geologique de Marquise) and as mentioned in many examples of orchids being at the intersection of faults.

Orchids can be a crude but possibly reliable tool to complement a structural interpretation even in areas with outcrops.

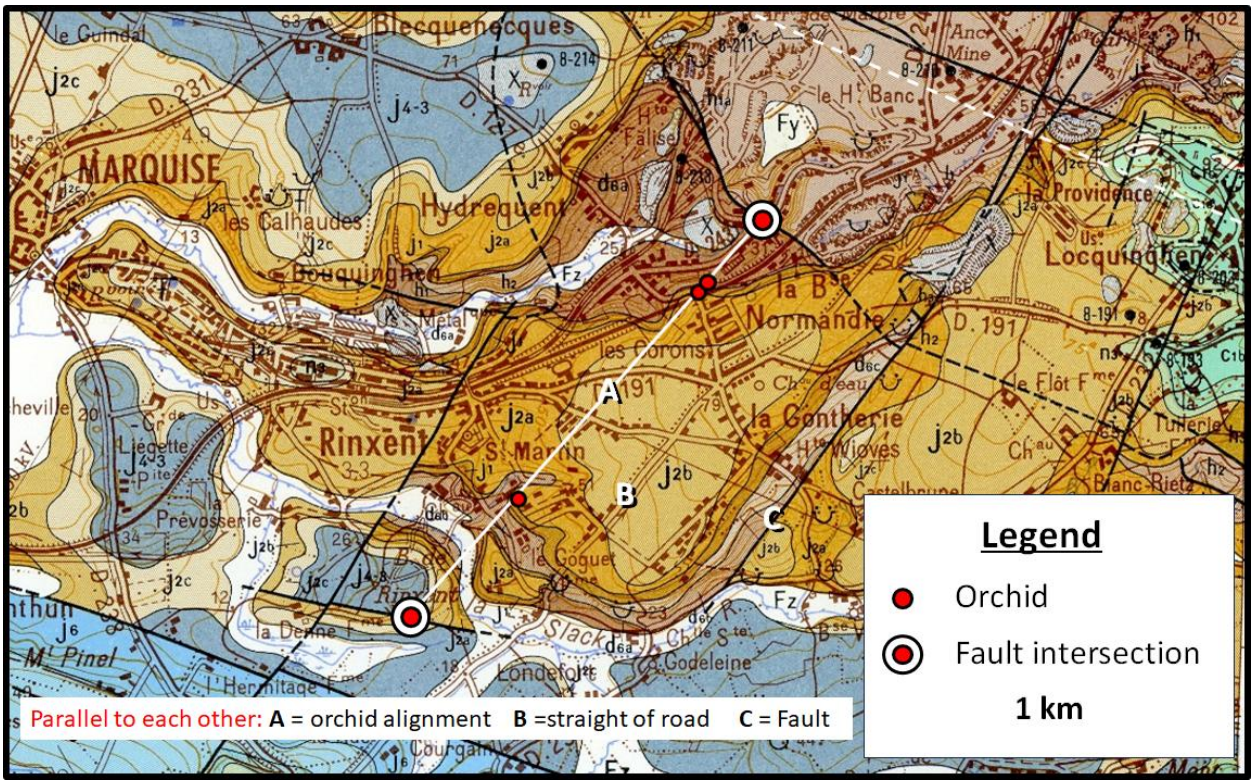


Fig.14 Geological map around Rinxent covering the southern part of the massive Ferques quarry and showing parallelism between faults, orchid alignments and long straights of roads as well as orchids occurrences at the intersections of faults (partial Marquise geological map 1971)

Acknowledgements

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Orchids near Arbour Lake, GBIF.org (04 January 2026) GBIF Occurrence Download https://doi.org/10.15468/dl.a3gf3p

Databases

GBIF: Global Biodiversity Information Facility; it is an international network and data infrastructure funded by the world's governments and aimed at providing anyone, anywhere, open access to data about all types of life on Earth.

iNaturalist: it shares people findings with scientific data repositories like the Global Biodiversity Information Facility (GBIF) to help scientists find and use the recorded data. This is open to everyone and is available in map form. Every observation can thus contribute to biodiversity science.