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The Poitou Threshold

T. Gaillard and P. Branger

Location and definition

The Poitou region is a natural area located between the Paris and Aquitaine basins, and between the Massif Central and the southeastern terminus of the Armorican Massif (France). This unique geographical configuration has led Poitou to be alternatively conceptualized as a strait (Longuemar, 1870; Welsch, 1892; Fournier, 1888) or as a threshold (Welsch, 1892; Gabilly, 1962).

The term "strait" refers to the marine channel that once connected the Paris and Aquitaine basins, while the term "threshold" denotes a region of intermediate elevation located between higher and lower elevations. From a geological perspective, the Poitou region is characterized as a strait, whereas geographers consider it a threshold. Both terms describe the same physical reality. "Geologists refer to this region as the Poitou Strait to indicate its role in connecting the sedimentary formations of the Paris Basin with those of the Aquitaine Basin. This concept of a strait stems from the interpretation that the Jurassic deposits of the Poitou Threshold represent sediments from a marine channel or strait extending between the Paris and Aquitaine basins" (Welsch, 1903).

Welsch further elaborates: "Since the region around Poitiers is, in fact, a zone of lower elevation relative to the Limousin and Vendee areas that it separates, it is appropriate to designate it as the Poitou Threshold".

The threshold is thus defined by its intermediate elevation, its position between low-lying sedimentary basins and higher ancient massifs (Fig. 1). This geographical definition was adopted by Welsch, who described Poitou as "a vast plateau

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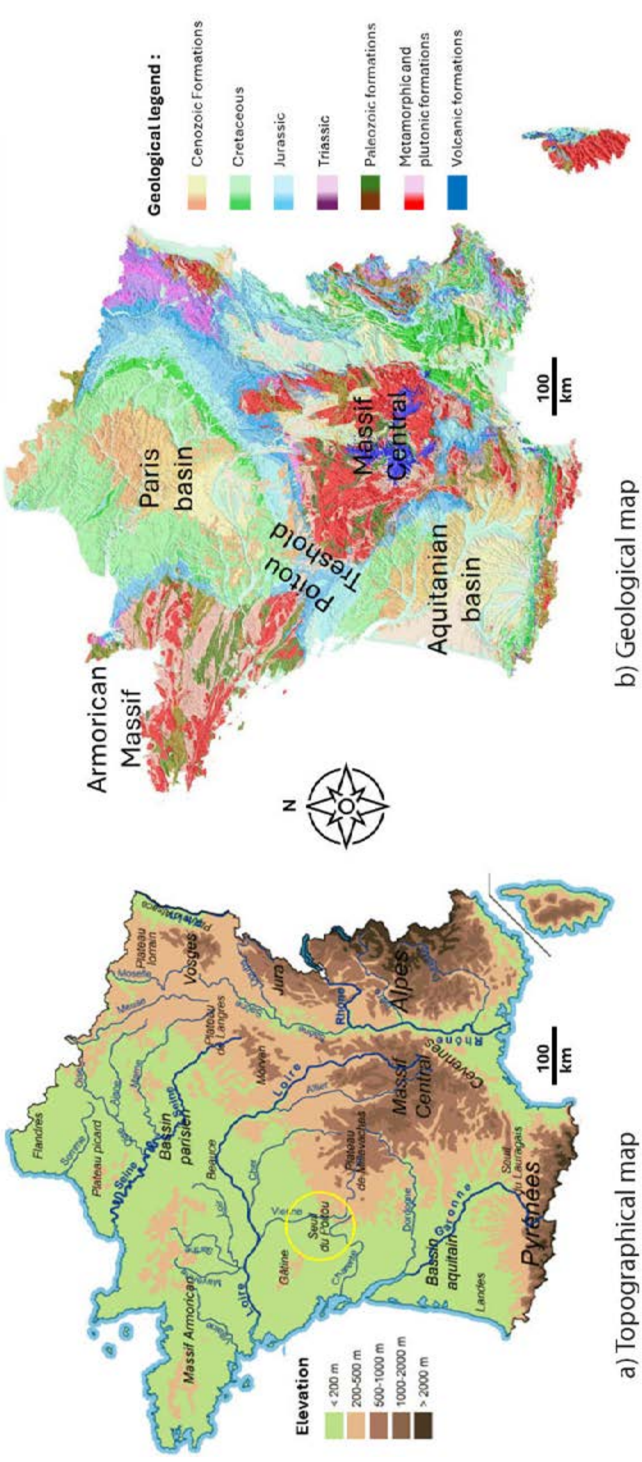


Figure 1 *Poitou threshold location.*

encompassing most of the Vienne department, the southern part of Deux-Sèvres, and the northern part of Charente. Its average elevation is 146 meters above sea level, with a gradual rise to the east and southeast toward Limousin, reaching 200 meters at Lathus and 225 meters beyond Isle-Jourdain. To the west, the elevation against the Vendée Massif reaches altitudes of 160 to 190 meters" (Welsch, 1892). The adoption of these concepts likely reflects the influence of geographical studies, particularly the maps produced by Vidal-Lablache, which were widely employed in educational settings during the French Third Republic. But the topographic approach suffers from the fact that no elevation was selected to define the threshold's limits/boundaries.

Tectonic structure of the Poitou Threshold: a brief history of knowledge

Welsch (1846, 1892) proposed the first tectonic structure of the Poitou Threshold, including two cross-sections: one cross-section that links the old Hercynian Mountain ranges and another that links the sedimentary basins (see Fig. 2 and 3).

In the first cross-section (Fig. 2), Welsch noted only one fault: the Montalembert Fault, located south of the Deux-Sèvres department. The bedrock includes two major anticlines that connect ancient massifs: the Champagné-Saint-Hilaire anticline and the Ligugé anticline. The Poitou area was described as a strait (isthme in French on Fig. 2).

The second cross-section (Fig. 3) links the Armorican and Limousin massifs, showing sub-horizontal sedimentary layers between Ménigoute (West) and Availles-Limouzine (East). The bedrock crops out at both ends. In this figure, the Poitou area was identified as a threshold (Seuil in French in Fig. 3).

Glangeaud's observations refined earlier interpretations by identifying faults that isolate the Champagné-Saint-Hilaire anticline from "collapsed layers" (Glangeaud, 1895). Fournier (1903) later produced a geologic map of the Poitou Threshold. After World War I, Mathieu (1937) conducted additional structural studies for his thesis on Paleozoic terrains in the Vendée region. He identified structural links between the Limousin and Gâtine Hills, revisiting the mapped features of Welsch. Mathieu described four major structural axes, listed from north to south (Fig. 4): A4 – the Ligugé Anticline; A3 – an anticline extending from Le Fouilloux, through Lusignan and Champagné-Saint-Hilaire to Availles-Limouzine; A2 – The Rouillé-Couhé-Civray Axis (also called the Saint-Sauvant Anticline), and A1 – a complex anticline connecting Mervent to the Montalembert Horst.

Axes A5 and A6 were not traced further east due to a lack of structural markers. The major axes were later integrated into the regional geological guide (Gabilly et al., 1978) under the names Essarts-Mervent-Melle-Montalembert Anticline (A1)

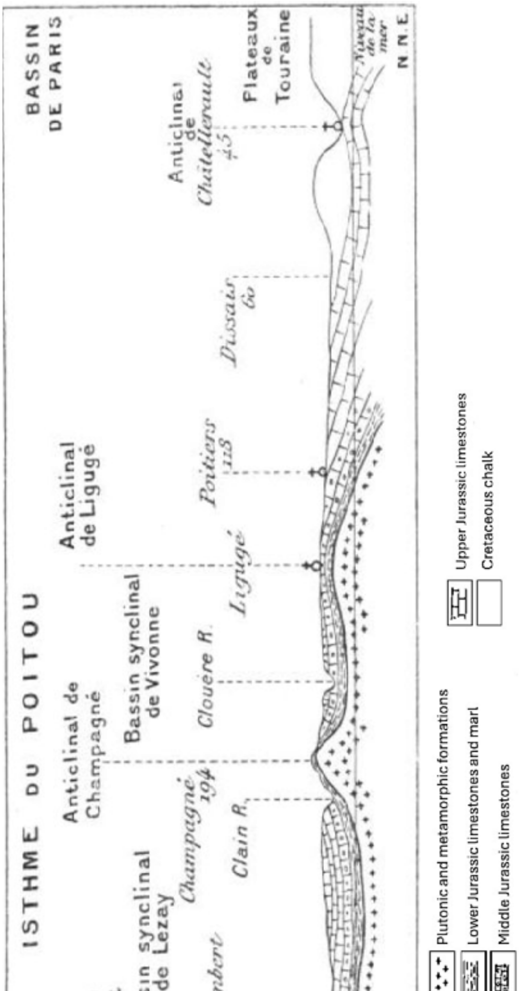


Figure 2 *SSW-NNE cross-section connecting the Aquitaine basin to the Paris basin (Welsch, 1892).*

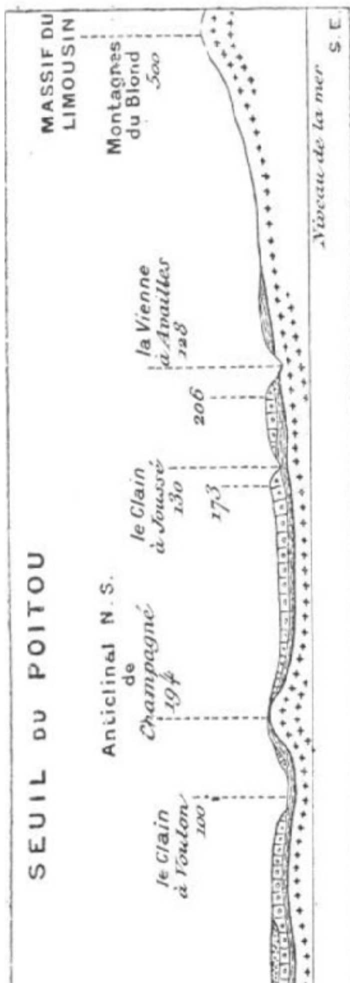
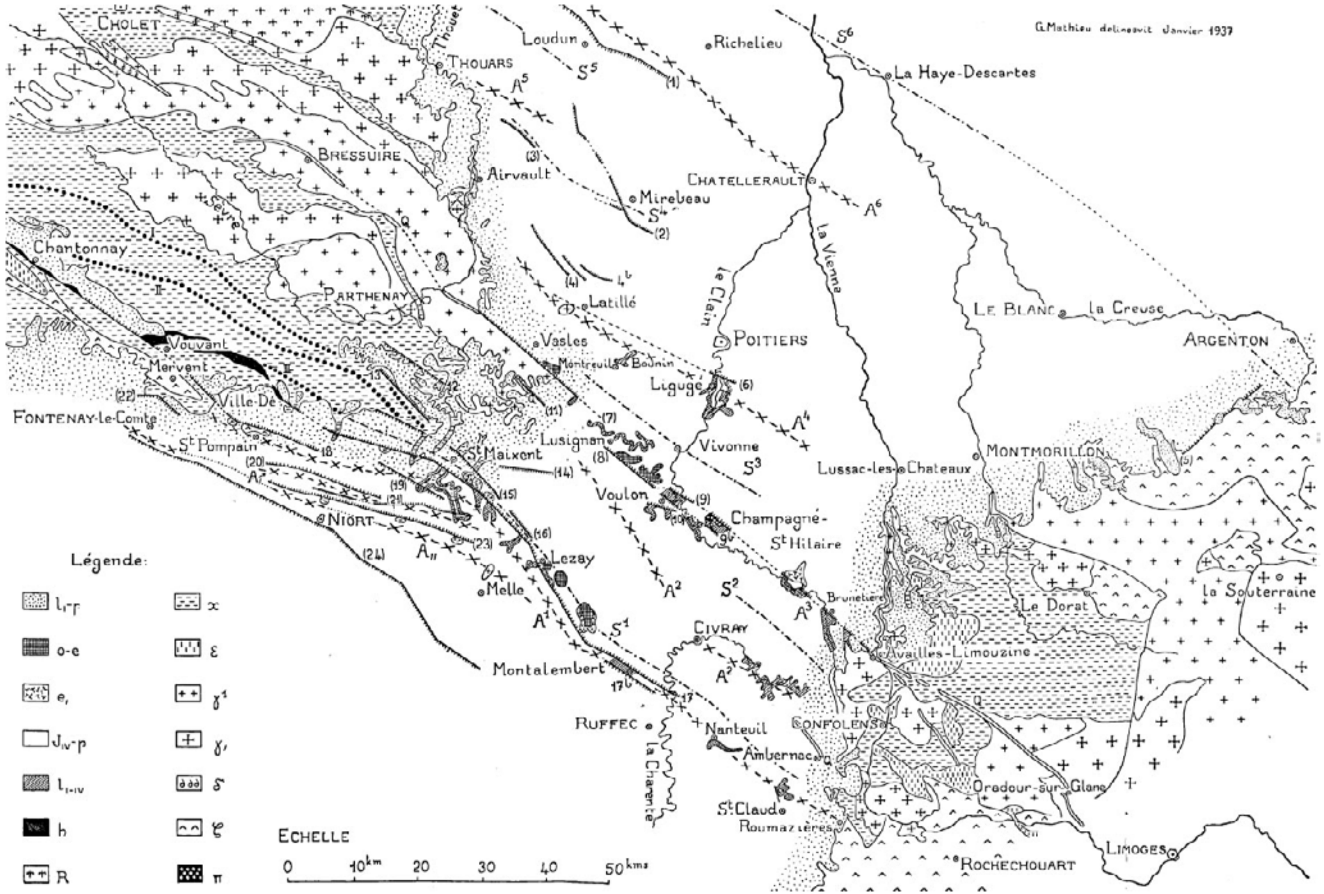


Figure 3 *NW-SE cross-section connecting the Armorican and Limousin massifs (Welsch, 1892).*



L1-p: Triassic formations; o-e: *"siderolic"* formation (clay with ferruginous pisolite), e = lacustrine marl (Eocene); JIV-p: Mesozoic limestones, L1-IV: lower Jurassic formations; h: "houiller" = coal formations; R: rhyolite of Cholet; x: shists; ε: amphibolite; γ1: granulite; γ2: granite; δ: diorite; ξ: gneiss; π porphyry; Q: quartz - A: anticline, S = syncline.

Figure 4 *Structural axes of the Poitou threshold by Mathieu (1937, p. 289).*

and Champagné-Saint-Hilaire Anticline (A3). This structural framework, based on a model of parallel fault alignments extending from the Limousin to the Vendée along a south-Armorican trend N120°E/N140°E (Fig. 5), prevailed until the early 1990s.

In the 1980s, this structural model was reinforced by the identification of the Limousin Tonalitic Line (LTL) linking the Parthenay Massif to Limousin granites and the Availles-Limouzine Fault (Dhoste, 1983; Peiffer, 1987; Cuney et al., 2001). North of the threshold, the Marche Fault line is well documented only in the southern Berry area. This fault system between the Massif Central and the Paris basin was long unknown westward beneath the Poitou Threshold. Early indications came from gravimetric anomalies (Goguel, 1954) and a magnetic anomaly map of the Paris Basin (Debeglia, 1980).

Figure 6 shows the correspondence between mapped faults and the gravity map of Martelet et al. (2009). The light gravimetric anomaly indicates the Eo-Variscan suture between Gondwana (or Central Armorica) and Laurussia and appears to cross the threshold without faulting in the sedimentary coverage. This contact is also highlighted by a negative Bouguer anomaly (Baptiste, 2017). The Nort-sur-Erdre Fault marks the Ligérienne Province boundary and coincides with the light Bouguer anomaly. This fault is interpreted as an Eo-Variscan suture (Dercourt, 1998) and extends towards the Loudun fault.

Goguel's (1954) heavy gravimetric anomaly north of Poitiers is aligned with the eastern extension of the Thouars fault (Weber, 1973). This anomaly corresponds to a contact of Jurassic and Upper Cretaceous sediments, suggesting that the Thouars fault is a heritage that gave rise to the Thouars granitic intrusion. The Mirebeau fault is aligned with the Thouars fault. However, no faults are mapped east of Mirebeau on the Vouneuil-sur-Vienne geological map (Bourgueil et al., 1976). Seismic activity in this area (e.g., a magnitude 3.2 earthquake in Saint-Léger-La-Pallu on June 14, 2019) reinforces the hypothesis of a fault that extends from the Armorican Massif and is masked by Eocene formations.

Further studies, including a study on the Parthenay Fault (Poncet, 1993) and ANDRA's recognition of the Charroux Granite in the late 1990s, revised the structural map of the bedrock of the Poitou Threshold. These studies revealed three main structures originating from the Armorican Massif (Fig. 7):

(i) the Vasles-Availles Fault Zone, passing through Champagné-Saint-Hilaire (formerly the Pouzauges-Oradour axis of Cariou et al., 1989);

(ii) the Parthenay Fault, trending N160°E, which connects to the Saint-Maixent and Lezay grabens rather than the Vasles Fault and Champagné-Saint-Hilaire Horst (Poncet, 1993; Cuney et al., 2001; Rolin and Colchen, 2001);

(iii) the Basse Marche Fault, south of Poitiers, is linked to the Ligugé Granite and extends to the Thouars Fault (Rolin and Colchen, 2001) via the Mirebeau fault.

Rolin et al. (2009) consider these fault systems to be shear zones. Figure 7 is a schematic map of Paleozoic faults and granites from Rolin and Colchen (2001) and

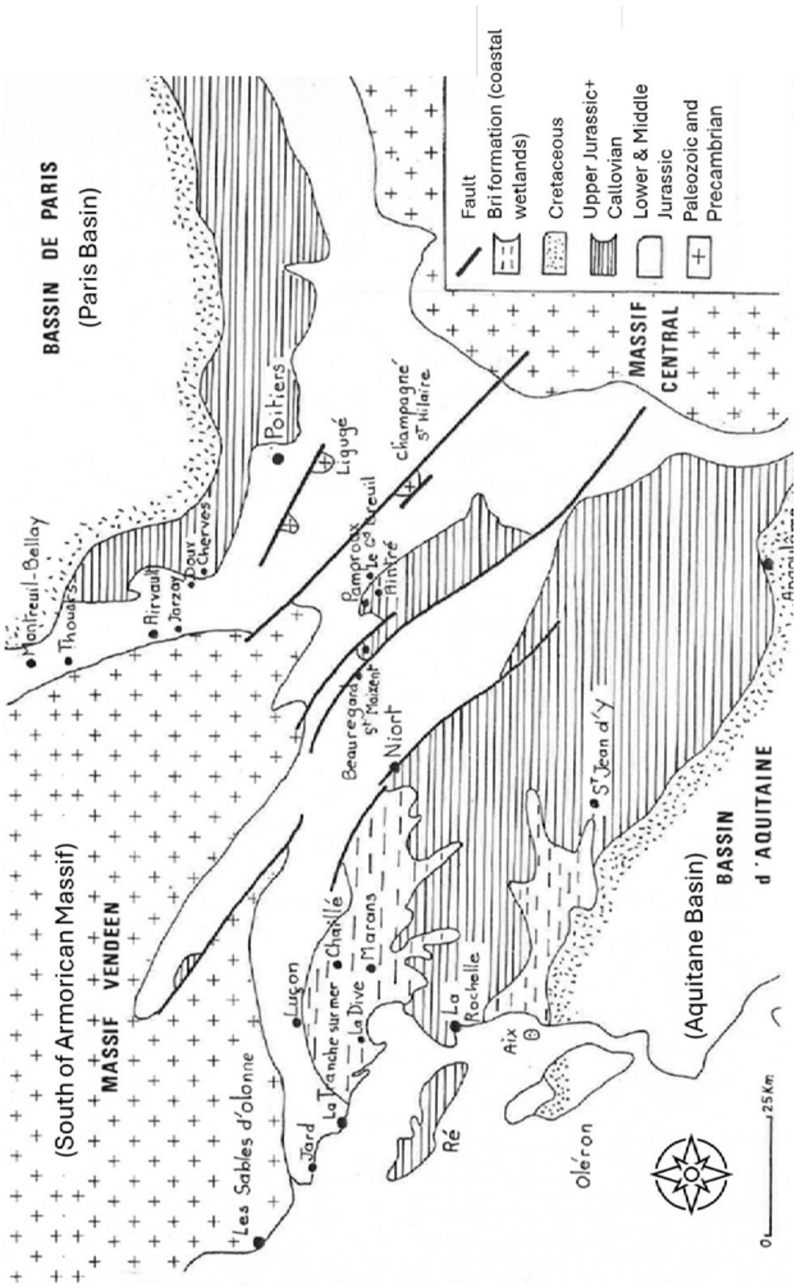


Figure 5 *Poitou threshold structure (from Gabilly and Cariou, 1974)*

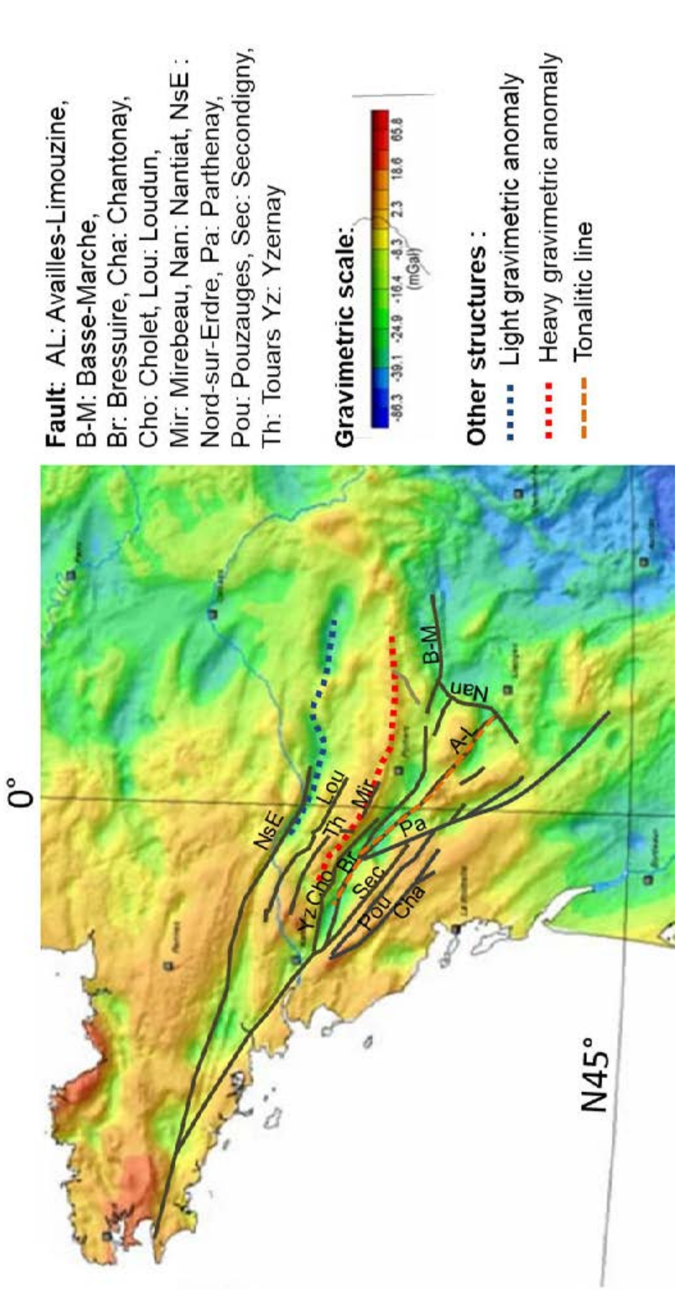


Figure 6 *Fault system and gravimetry map (from Martelet et al., 2009).*

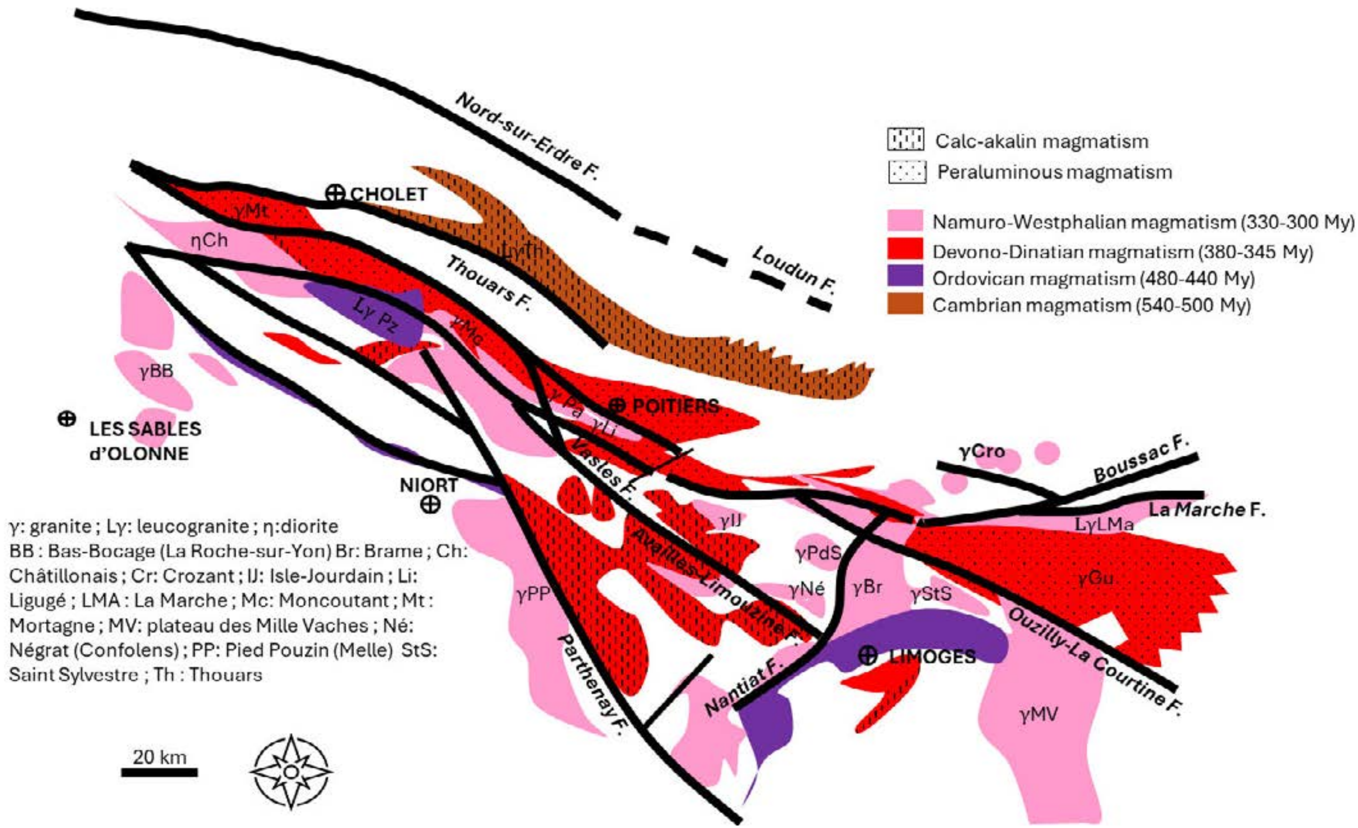


Figure 7 *Schematic map of Paleozoic faulting and calc-alkaline magmatism.*

Rolin (2001). Granites intruded the Paleozoic sediments during the Cambrian, Ordovician, Devonian-Visean, and Namurian-Westphalian (Carboniferous). The primary granitic intrusion activity occurred between the Devonian and the Westphalian (Moscovian). Calc-alkaline magmas may be the result of the fusion of a mantle layer intruded into the tectonics of the threshold between the Parthenay fault and the Vasles-Availles fault (Rolin et al., 1999).

Sedimentary coverage

Granites and Paleozoic metamorphic formations make up the bedrock that is covered by Jurassic formations. Triassic sediments are located only at the threshold border (Infra Lias clay in the Aquitanian basin and arkose in the Paris basin).

During the Early Jurassic (Sinemurian and Hettangian), shallow marine environments dominated the Poitou Threshold. The sediments consist primarily of shallow marine carbonates. During this period, three sedimentation areas were active: (i) the Atlantic area west of Fontenay-le-Comte, (ii) a Vendean area between Fontenay-le-Comte and Thouars, and (iii) the “Pictave” area around Poitiers (Gabilly and Cariou, 1974). The Toarcian is marked by the deposition of dark, organic-rich marls and shales, indicative of deeper, more anoxic conditions associated with the global Toarcian Oceanic Anoxic Event (TOAE).

Between the Aalenian and the Callovian, sedimentation transitioned to shallow marine carbonate platforms. These include micritic limestones, bioclastic limestones, oolitic limestones, and occasional reefal buildups. The Oxfordian is represented by limestones in the Pictave area. The sedimentary facies are marly from the Vendean to the Atlantic area. During the middle Jurassic, the sedimentation area was limited by the fault(s) inherited from Paleozoic tectonics (Mourier and Gabilly, 1985).

Fossils, particularly ammonites and brachiopods, are critical for establishing relative ages due to their stratigraphic distribution and global correlation. While ammonite dating is accurate towards the basins, the scarcity of pelagic fauna in the middle of the Poitou threshold makes dating a delicate matter. For this reason, Gabilly studied signs of exposure and erosion registered in limestones and the biozone gap (Gabilly, 1962). This evidence is used to make correlations between the Poitou threshold and the Aquitanian basin margin (Gabilly et al., 1985).

Gabilly et al. (1978) proposed a cross-section of the Poitou threshold, which is still valid (Fig. 8). The threshold affects sedimentation in several ways. The first is a thinning of the geological layers. The second is a facies variation, with carbonate facies on the threshold and marly facies towards the basins. The anticlines and synclines of the cross sections are associated with the fault system shown in Figure 8. No faults were identified as being related to the Paris Basin.

As a result of the new fault pattern shown in Figure 7, the facies distribution of the middle Jurassic deposits could be revised. For example, Figure 9 shows the facies distribution during the upper Bathonian, as mapped by Gabilly et al. (1978). With

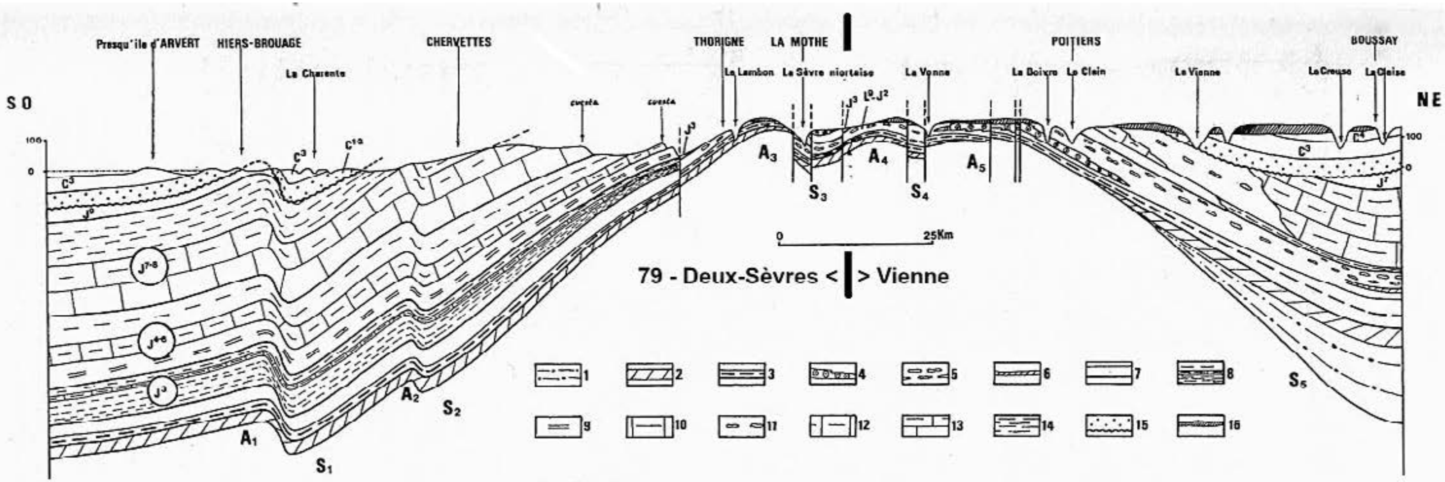


Fig. 11. – *Coupe transversale du Seuil du Poitou.*

Stratigraphie. – 1. Série argilo-sableuse (Permo-Trias ? à Hettangien) ; – 2. Calcaires dolomitiques sinémuro-hettangiens ; – 3. Pliensbachien et Toarcien ; – 4. Calcaire oolithique (Aalénien et Bajocien inférieur) ; – 5. Calcaires grenus à silex (Bajocien, Bathonien et Oxfordien) ; – 6. Dolomies bajociennes ; – 7. Calcaire fin à Céphalopodes ; – 8. Callovien aquitain à dominante marneuse ; – 9. Marnes de l'Oxfordien inférieur et moyen ; – 10. Calcaires argileux de l'Oxfordien supérieur (versant aquitain) ; – 11. Calcaires grenus à silex de l'Oxfordien (versant parisien) ; – 12. Calcaire argileux oxfordien (versant parisien) ; – 13. Calcaires micritiques argileux au sommet (Kimméridgien inférieur, versant aquitain) ; – 14. Marnes à *Exogyra virgula* (Kimméridgien supérieur) ; – 15. Cénomanien ; – 16. Couverture tertiaire ; – L 9-J 2. – Aalénien à Bathonien. – J 3. Callovien ; – J 4-6. Oxfordien ; – J 7-8. Kimméridgien ; – J 9. Portlandien ; – C 1-2. Cénomanien ; – C 3. Turonien ; – C 4. Sénonien.

Tectonique. – A 1. Anticlinal saintongeais ; – S 1. Synclinal de Saintes ; – A 2. Anticlinal de Muron ; – S 2. Synclinal de Genouillé ; – A 3. Axe anticlinal de Montalembert ; – S 3. Cuvette synclinale de Saint-Maixent – La Mothe-Sainte-Héraye ; – A 4. Axe anticlinal de Champagné-Saint-Hilaire ; – S 4. Cuvette synclinale de Jazeneuil ; – A 5. Anticlinal de Ligugé ; – S 5. Cuvette synclinale de Beaumont-Martizay.

Noter la forme de voûte à peu près symétrique du substratum cristallin, l'épaisseur des assises anté-calloviennes du côté NE (bassin de Paris) et le développement des étages callovien, oxfordien et kimméridgien au SO dans le bassin d'Aquitaine. L'amplitude des déformations de la couverture apparaît relativement faible comparée à la courbure d'ensemble du Seuil.

Figure 8 *Cross-section of the Poitou threshold (Gabilly et al., 1978).*

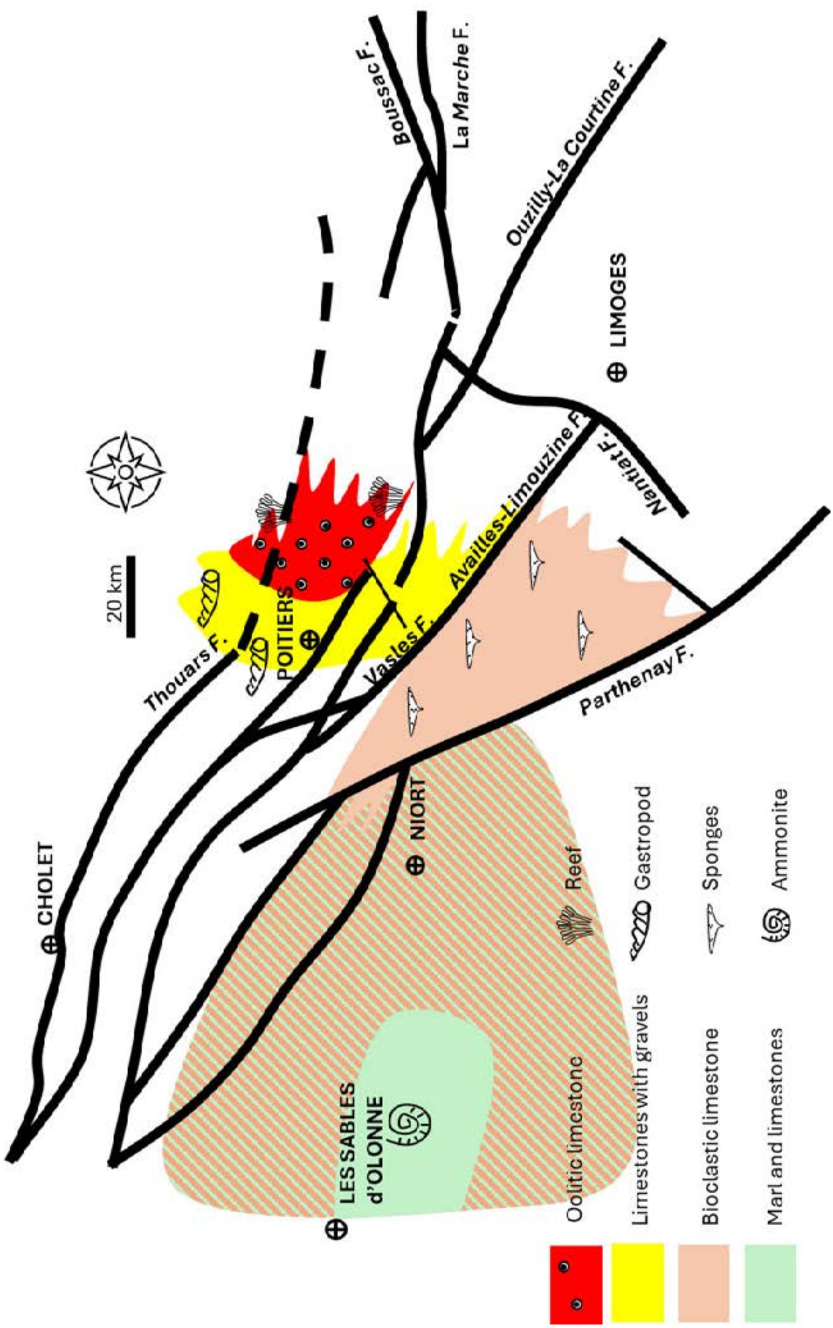


Figure 9 *Facies distribution during the upper Bathonian (from Gabilly et al., 1978).*

the proposed schematic fault map, the various areas of sedimentation are superposed onto tectonic blocks. High-energy facies (oolitic limestones) were placed between the faults that delimit the Pictave block. Gravelly limestones that extended to the west were pinched out against the Vasles-Availles fault. Bioclastic limestone with sponge beds was confined to the area between the Vasles-Availles fault and the Parthenay fault. To the west of the Parthenay fault, sedimentation was marly.

Poitou threshold definition

Gabilly et al. (1978) mapped the facies distribution for the Toarcian, lower Bajocian, and Callovian. Mourier and Gabilly (1985) mapped it in the Vienne and Charente valleys. The pattern of the fault system is similar to Figure 9.

The northern axis, which better limits the extension of high-energy facies, corresponds to the gravity anomaly parallel to the Thouars-Mirebeau fault. Sedimentation north of the Vasles-Availles-Limouzine axis is a carbonate platform environment, while to the south it becomes openly marine; this is the Vendean domain (Gabilly and Cariou, 1974; Mourier, 1983; Branger, 1989). The Vasles-Availles axis (roughly equivalent to the Pouzauges-Oradour axis of Gabilly, 1962; Mourier 1983; Branger, 1989) marks the end of the Poitevin Strait and the beginning of the Aquitaine Basin.

Defined in this way, the Poitou threshold appears to be a mid-Jurassic shoal, with the northern and southern limits of the platform aligned with the structuring axes inherited from the basement. The shorelines are controlled by these granitic horst sets from the Toarcian to the Bathonian. The platform continues into the Bajocian and Bathonian towards Berry. In the Callovian, however, the inherited higher elevations no longer seem to constrain sedimentation, and the gap in some Callovian ammonite zones extends over a vast plateau (Cariou, 1980). Although some authors have sometimes compared the Poitou threshold to a vast NW-SE anticline with a large radius of curvature (Gabilly, 1978), the geometry of the strata is sub-horizontal and is offset by normal faults. In fact, the geometry of the limestone strata on the Poitou platform conforms to cycles of sea-level variation and the creation of available space for proximal and distal depositional facies (Mourier, 1983; Branger, 1989; Gonnin et al., 1992). Based on structural maps, it is possible to give a purely geological definition to the Poitou Threshold as the region between the Thouars-Mirebeau fault to the north and the Vasles-Champagné-Saint-Hilaire-Availles-Limouzine axis to the south (Fig. 10). The advantage of this proposal is that it also represents the platform of the Pictave domain during the Jurassic (Gabilly and Cariou, 1974; Mourier and Gabilly, 1985).

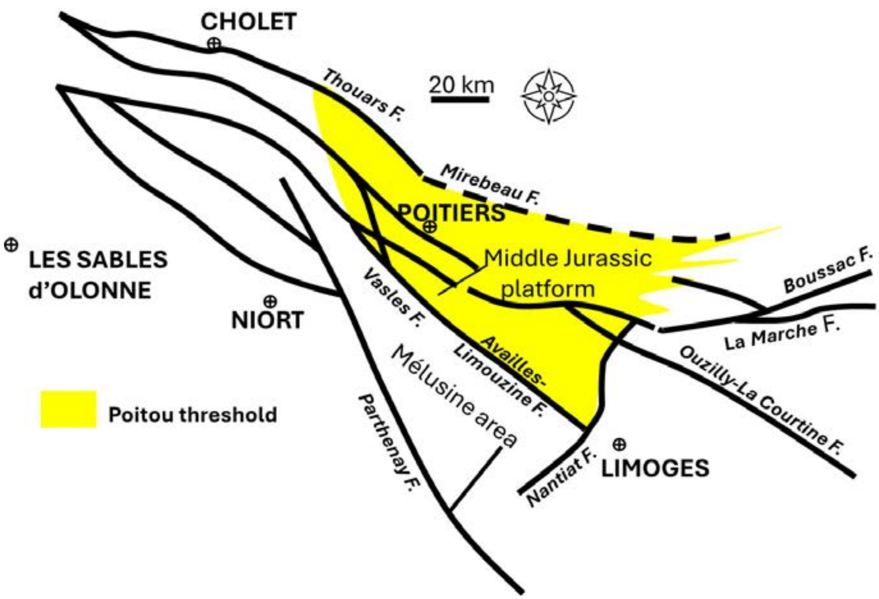


Figure 10 *The Poitou threshold defined by Dogger basement structure and platform facies.*

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