

# Paleoseismicity in the Spanish Central Range: evidence from the Pseudotachylites

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## ABSTRACT

*The granitoids of the SW Spanish Central Range show different episodes of formation of pseudotachylites, ranging from post-hercynian to alpine times, and which indicate paleoseismic activity in the area.*

## RESUMEN

*Los granitoides del SW del Sistema Central Español muestran diferentes episodios de formación de pseudotaquilitas, que abarcan desde tiempos post-hercínicos, hasta alpinos, y que indican actividad paleosísmica en el área.*

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**Key words:** *Pseudotachylites, granitoids, paleoseismicity.*

## Introduction

Numerous pseudotachylites are found within the granitoids of the southwestern Spanish Central Range (SCR) (fig. 1). This type of rocks, has only been described before in the SCR by Doblas *et al.* (1983).

Pseudotachylites are ultradeformed dark igneous rocks, vitreous in appearance, extremely fine-grained, with complex geometrical patterns (Wenck, 1978; Wise *et al.*, 1984). The mechanism by which they are generated is controversial, and may be due, either to melting by frictional heating (Maddock, 1983), or to extreme cataclasis (Wenck, 1978). However, everybody accepts that they are due to deformation along brittle faults with low water activity, that they represent seismic episodes, and that the presence of glass is not a prerequisite for their definition (Sibson, 1975; Sibson, 1980; Maddock, 1983; Passchier, 1984).

## Types of pseudotachylites

Three different types of pseudotachylites, with contrasting characteristics, are defined here, and they are classified temporally in relation to the tardi-hercynian transcurrent bands (fig. 1 and 2).

The first type, is composed of pseudotachylites formed *before* the onset of these *tardi-hercynian* bands (BTH), and they are associated to WNW/ESE-orientes/NE-dipping C shearing planes, showing an extensional motion to the NE (first recognized in the San Vicente granitoids, Doblas *et al.*, 1983). They display fault-vein geometries (Sibson, 1975), concordant with the distensive C shearing planes, with stretching lineations to the NE, and they appear as dark bands highly obliterated by later ductile deformation (strong recrystallization, foliation, and compositional banding) (fig. 2a). Their thicknesses

are between 10 cm and 1 m, and they have gradational contacts with the granites. Under the microscope, the matrix is fine-grained, and highly recrystallized, with floating porphyroclasts of subeuhedral feldspars, and quartz ribbons. These rocks, as they appear currently, are ultramyonites.

The second type, was formed *during* the generation of the ductile-brittle *tardi-hercynian* transcurrent bands, (DTH). They appear as concordant and discordant veins of the fault-injection type (Sibson, 1975), showing different geometries as lenses, networks, or breccias, and forming dark veins not thicker than 10 cm, with sharp contacts (fig. 2b). Under the microscope, they show fractured porphyroclasts of quartz and feldspars, having a fine-grained matrix with only minor obliteration (slight recrystallization, and no foliation development). These rocks, as they appear currently, are ultracataclases.

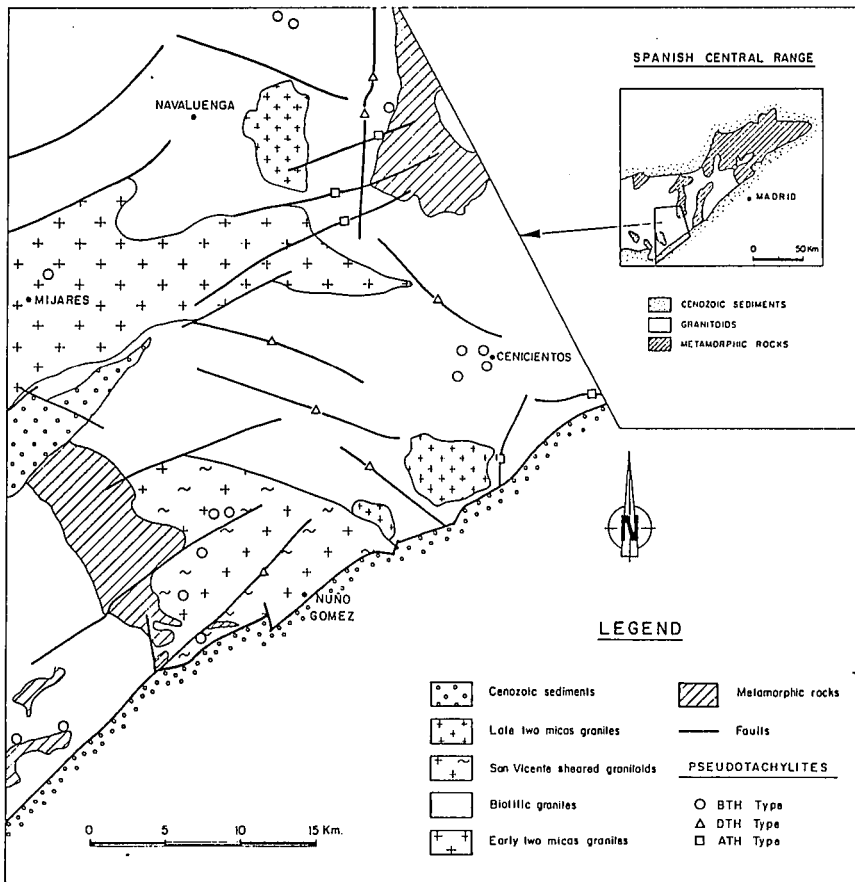


Fig. 1.—Geological setting of the pseudotachylites (cartography modified from Ubanell, 1982)

The third type, was formed *after* the *tardi-hercynian* transcurrent bands, (ATH), and they are associated to later brittle fractures, some of them of probable alpine age. They are highly discordant veins of the injection type (Sibson, 1975), with lenses or networks geometries, and their appearance is clearly the one of a dark glass, closely jointed, with thicknesses under 10 cm, and sharp contacts (fig. 2c). Under the microscope, they are glassy, cryptocrystalline, and only a TEM study could reveal their structures. These rocks are classifiable as pseudotachylites.

**Discussion**

The fact that pseudotachylites have not been described till now in the bibliography of the SCR, is easy to explain, as only the ATH type (rarely seen) truly pertains to this group, while the two other types (much more abundant), are «obliterated old pseudotachylites», presently classifiable as ultramylonites or ultracataclasites

(the occurrence of obliterated pseudotachylites is nothing new, Sibson, 1977; Sibson, 1980; Borradaile, 1982; Breaks & Bond, 1982; Passchier, 1984).

The rocks described here form three groups with contrasting degrees of later ductile obliteration, originally formed at different depths and times. BTH type pertains to a mainly QP (quasi-plastic, Sibson, 1977) regime of deformation, in deep extensional shear zones, indicating transient episodes of rapid seismic motions, within a general continuous slow aseismic deformation (Sibson, 1980). DTH type pertains to intermediate conditions between QP and EF (elastico-frictional, Sibson, 1977) regimes, in medium-depth ductile-brittle transcurrent bands. ATH type, which are pseudotachylites «sensu stricto», were formed under an EF regime, in later shallow brittle faults.

These rocks clearly indicate the existence, in the SCR, after the main hercynian deformations, of intermittent seismic episodes.

**Conclusions**

Both «old obliterated pseudotachylites», and «pseudotachylites sensu stricto», are recognized in the granitoids of the southwestern SCR, pertaining to three different deformational environments: deep pre-tardi-hercynian ductile extensional shear zones (BTH), medium-depth tardi-hercynian ductile-brittle transcurrent bands (DTH), and shallow post-tardi-hercynian brittle fractures (ATH). All of them, are «witnesses and proof» of paleoseismicity in the area.

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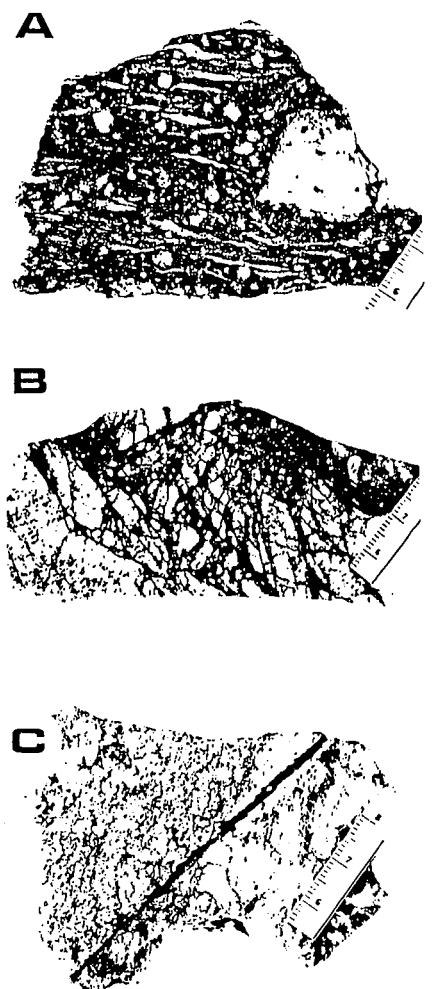


Fig. 2.—Pseudotachylite types: A) BTH pseudotachylite. B) DTH pseudotachylite. C) ATH pseudotachylite.

## References

- Borradaile, G. J. (1982): *Atlas of deformational and metamorphic rock fabrics*. Springer-Verlag, 368-369.
- Breaks, F. W. and Bond, W. D. (1982): *Atlas of deformational and metamorphic rock fabrics*. Springer-Verlag, 366-367.
- Doblas, M.; Capote, R., and Casquet, C. (1983): *Stvd. Geol. Salman.*, 18, 27-38.
- Maddock, R. H. (1983): *Geology*, 11, 105-108.
- Passchier, C. W. (1984): *Jour. Struct. Geol.*, 6, 273-281.
- Sibson, R. H. (1975): *Geoph. Jour. Roy. Astron. Soc.*, 43, 775-794.
- Sibson, R. H. (1977): *Jour. Geol. Soc. Lond.*, 133, 191-213.
- Sibson, R. H. (1980): *Jour. Struct. Geol.*, 2, 165-171.
- Ubanell, A. G. (1982): *Estudio de la fracturación en un segmento del Sistema Central español*. Tesis Doct. Univ. Complutense Madrid.
- Wise, D. U.; Dunn, D. E.; Engelder, J. T.; Geiser, P. A.; Hatcher, R. D.; Odom, A. L., and Schamel, S. (1984): *Geology*, 12, 391-394.

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## Comentarios

*G. de Vicente.*—¿A qué dirección de zonas de cizalla o fallas están asociadas las pseudotaquilas BTH?

*Respuesta.*—Las pseudotaquilas de tipo BTH se encuentran localizadas de forma discontinua y al azar a lo largo de planos de cizallamiento C de granitos deformados SC; estos planos tienen orientación WNW-ESE y buzamiento al NNE, indicando un movimiento distensivo hacia el NNE.

*R. Vegas.*—El trabajo presentado por M. Doblas no corresponde en realidad a un trabajo sobre paleosismicidad, ya que no ofrece datos sobre la recurrencia de sismicidad en esta zona. No obstante,

supone una contribución al estudio de las pseudotaquilas en el Sistema Central.

*Respuesta.*—El concepto de la palabra *paleosismicidad* al que se refiere usted está en relación con procesos neotectónicos, en los cuales se estudian episodios sísmicos recientes, mediante criterios estructurales, geomorfológicos y estratigráficos. Sin embargo, en nuestro trabajo estudiamos procesos paleosísmicos durante épocas mucho más antiguas (tiempos posteriores al hercínico hasta tiempos alpinos) y los únicos indicadores posibles en estos casos son las pseudotaquilas presentes en rocas graníticas del basamento actualmente aflorante. De hecho, se utiliza este término en trabajos clásicos sobre pseudotaquilas y sismicidad (Sibson, 1975, página 791: «... where Pseudotachylite is associated ... it may be used as an indicator of *paleoseismic* activity...»), en relación con sismicidad paleozoica. El concepto de la palabra *paleosismicidad* no es únicamente aplicable a procesos neotectónicos, como parece usted indicar, sino a cualquier episodio sísmico antiguo (de allí el prefijo *Paleo*), tanto «paleotectónico» como «neotectónico».