Oxygen Isotopic data for the early and late diagenetic chert in carbonate turbidites (Upper Cretaceous), Northeast Bilbao, Spain

Valores isotópicos del oxígeno de los sílex temprano y tardío en turbiditas carbonatadas (Cretácico superior), NE. Bilbao.

J. Elorza y A. E. Fallick*

Depto. Mineralogía-Petrología. Universidad País-Vasco; Apart. 644; 48080 Bilbao.
Isotope Geology Unit, SURRC, East Kilbride, Glasgow G 75 OQU; Scotland.

RESUMEN

Se han obtenido los valores de δ^{18} O (SMOW) de dos tipos de sílex (temprano y tardío) presentes en las turbiditas carbonatadas de la Formación Plencia (Cuenca Vasco Cantábrica). El sílex temprano tiene unos valores medios de 29.3 ± 0,45 ‰ (n=9), mientras que el sílex tardío alcanza 28.3 ± 0,37 ‰ (n=5). A partir de la expresión de Kita et al. *(1985) sugerimos que el sílex temprano fue formado a una tº entre 45-55º C, según los valores δ^{18} O (H_2O) = 0 ± 1‰, y que el tardío supera en unos 5º C tal temperatura, considerando semejante la composición de los fluidos intersticiales.*

Key words: *Oxygen Isotope, Chert, Coniacian, Carbonate turbidites, Bosque-Cantabrian Basin.*

Geogaceta, 10 (1991), 79-81.

Introduction and occurrence of chert

During the Upper Cretaceous, the Basque-Cantabrian Basin was fractured and divided into three large sedimentation areas (Basque Arc, Navarro-Cantabric trough and north Castellain carbonate platform), (Rat, 1982; Rat et al. 1982). The Plencia Formation, defined by Mathey (1982), belongs to the Basque Arc. It is composed of carbonate turbidites (calcareous flysch) of Coniacian age. At the middle part of this Formation appears an important and widespread silicification diagenetic process. In particular, near Barrika village, the bedded and nodular chert is clearly exposed and it was studied under crystallographic (Elorza, *et al.*, 1985) and petrologic-geochemistry (Elorza and Bustillo, 1989) points of view.

On the other hand, a large olistostrome deposit dated as Upper Santanian-Early Campanian (Elorza *et al.*, 1987) occurs and marks an important depositional even within the Eibar Formation. It is composed of different rock fragments (conglomerates, sandstones, basalts, marls limestones, chert, etc.) and ages (Cenomanian, Coniacian, etc.). At the botton of the olistostrome deposit there are large blocks of carbonate turbidite beds (Plencia Formation) including bedded and nodular chert (early chert), and here appears fracture-related chert. This new chert has a later diagenetic origin and cross-cuts, with irregular contact, the sedimentary structures and the early-formed chert.

Petrography and origin

Most of the silica minerals are in the form of micro and cryptocrystalline quartz. A fibrous variety of quartz (chalcedonite) is a minor component and appears to have infilled axial canal of sponge spicules, radiolarian chambers, and other original sediment voids. There are no clear mineralogical and textural differences in quartz in bedded chert and fracture-related chert, only the timing of silicification is different. The silica was derived from the early dissolution and calcitization of sponge spicules and radiolarians mixed in the carbonate turbidites. The later stage fracture-related chert apparently came from a later stage calcitization of siliceous test and also from a partial remobilization of the early formed chert. The silicification here, is not a simple infilling of an open fracture, but is mainly a replacement of the adjacent carbonate rock.

Oxygen isotopic data

The methodology has been given previously (Fallick *et al.*, 1985). Data for silicate δ^{18} O (SMOW) for 9 early bedded-nodular chert and 5 later fracture-related chert from Plencia Formation, are given in Table I and fig. 1.

Tabla 1

EARLY BEDDED AND NODULAR CHERT

Sample	δ^{18} O‰ (SMOW)
Nº 1	29.35
Nº 3	29.81
Nº 4	29.15
Nº 5	29.55
Nº 7	29.78
Nº 8	29.70
Nº 10	29.18
Nº 11	28.88
Nº 12	28.46
n = 9...............	29.3 ± 0,45 (1σ)

STANDARD ERROR ON MEAN ± 0.15‰

LATER FRACTURE-RELATED CHERT

Sample	δ^{18} O‰ (SMOW)
NF-1	28.06
NF-2	28.20
NF-4	28.70
NF-5	28.54
NF-6	27.77
n = 5...............	28.3 ± 0,37 (1σ)

STANDARD ERROR ON MEAN ± 0.17‰

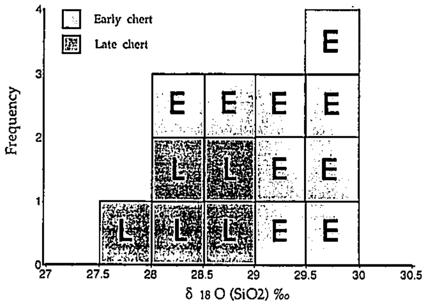

Fig. 1.

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We assume, as many others researchers (Murata *et al.*, 1972; Knauth and Epstein, 1976; Kolodny and Epstein, 1976; etc.) that δ^{18} O in cherts is the latest transition of opal CT to quartz, and it is not the original precipitation of any siliceous phase from the ocean, as e.g. opal A from the sponge spicules.

Discussion and conclusion

We can see at least two possible reasons for the systematic 1‰ difference between the early and later chert δ^{18} O: a) both cherts formed from fluid of identical δ^{18} O but at different temperatures; b) both chert formed at the same temperature but from isotopically distinct fluids. We know, that the bedded-nodular cherts are formed in the Plencia Formation (carbonate turbidites of the Coniacian age) and the later fracture-related cherts are found within big fragments of Eibar Formation (sandy flysch of the Santonian-Campanian age). The Eibar Formation was deposited deeper and later than Plencia Formation; thus, we suggest than both cherts were formed from fluids of similar δ^{18} O, delate this, but with different temperatures given the difference in depth between them.

There are several expressions in the literature (Matsuhisa *et al.*, 1979; Knauth and Epstein, 1976; Kita *et al.* 1985), which suggest a relationship between δ^{18} O (H_2O), δ^{18} O (SiO_2) and temperature; all assume that the silica is formed in isotopic equilibrium with the interstitial fluid. The three calibrations do not give the same answer, we choose the last (Kita *et al.*, 1985)

$$\delta^{18}\mathrm{O}\,(SiO_2) - \delta^{18}\mathrm{O}\,(H_2O) = 3.52.\,10^6\,T^{-2} - 4.35$$

Temperature	Early Chert	Temperature	Late Chert
X_1	Y_1	X_2	Y_2
28.80	-5.00	32.80	-5.00
41.30	-2.00	45.70	-2.00
50.40	0	55.30	0
60.50	2.00	65.90	2.00
77.50	5.00	83.80	5.00
0	-13.60	0	-14.60
4.00	-12.20	4.00	-13.20

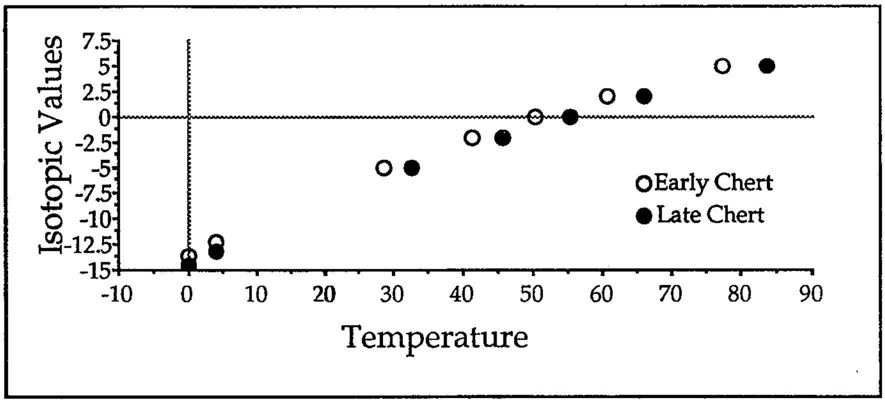

Fig. 2.—Table and plot of isotopic values δ^{18}O (H_2O) versus tº.

Fig. 2.—Tabla y diagrama de valores δ^{18}O (H_2O) frente a tº.

We can obtain the following graph δ^{18} O (H_2O) versus tº (fig. 2). We can see that the 1‰ in δ^{18} O (SiO_2) systematic difference corresponds to a ~5º C temperature difference (with later fracture-related cherts forming at higher temperature). For formation water δ^{18} O = 0±1‰ we find 45 < tº ¢<55.

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Recibido el 31 de enero de 1991
Aceptado el 1 de marzo de 1991

Pregunta M. Lamolda:

¿En qué medida los valores δ^{18}O hallados en el sílex secundario podrán estar influidos por la removilización en sí y no como un efecto de la temperatura?

Respuesta de los autores

Parece claro que la diferencia de los valores isotópicos mencionados entre el sílex temprano y el sílex tardío se produce por la propia removilización del sílex temprano, además de por un mayor grado de calcificación de los restos de espículas de esponjas silíceas. Pero este proceso se realiza a favor de unas condiciones batimétricas diferentes a las que conformaron el sílex temprano.

Sabemos que el sílex tardío se formó en materiales de la Formación Plencia después de haber sido deslizados hacia zonas más profundas, dada la naturaleza olistostrómica donde se encuentran y que, en buena lógica, debieron soportar una mayor temperatura. Creemos que es procedente admitir una mayor influencia de la temperatura frente a la posible variación isotópica de los fluidos, dada la misma fuente endógena de la sílice y que son razonables los 5º C de diferencia sugeridos.

Control tectónico de las características sedimentológicas del sistema aluvial de Cobatillas (Provincia de Teruel)

Tectonic control of the sedimentological characteristics of the Cobatillas alluvial system (Teruel province, Spain)

A. González*, C. Arenas*, G. Pardo* y J. Guimerà**

* Dpto. Ciencias de la Tierra. Facultad de Ciencias. Universidad. 50009 Zaragoza

** Dep. Geología Dinàmica, Geofisica i Paleontologia. Facultat de Geologia. Zona Universitària de Pedralbes. 08028 Barcelona

ABSTRACT

The Cobatillas alluvial system consists of two short superposed fans. The upper one shows wet fan facies within a semiarid climatic context. This is due both to the sediment source size, which is situated at the back of the oblique ramp of the Muela de Montalbán thrust sheet, and to the basin southern margin subsidence originated by the thrust in such margin

Key words: *Alluvial fan, thrust sheet, tectonic-sedimentation relationship, Tertiary, Iberian Range.*

Geogaceta, 10 (1991), 81-83.

Introducción

La cubeta de Aliaga se sitúa en el extremo más occidental de la Zona de Enlace, justo en contacto con la Cordillera Ibérica (fig. 1) y tal y como han señalado Guimerá (1988) y Guimerá *et al.* (1990), se dispone sobre la lámina de cabalgamiento de la Muela de Montalbán por lo que constituye, al menos en algunos momentos de su evolución, una cuenca de *piggy-back*.

Su relleno terciario ha sido subdividido por González (1989) en seis unidades tectosedimentarias, denominadas de muro a techo como A_1 a A_6. Dichas unidades aparecen limitadas por rupturas sedimentarias de tipo 1 ó 3 en el sentido de González *et al.* (1988), rupturas que son la manifestación en el registro estratigráfico de variaciones en la actividad diastrófica. En consecuencia la naturaleza del relleno terciario de la cuenca está íntimamente ligada a la estructuración alpina de este sector de la Zona de Enlace.

De las UTS diferenciadas, las inferiores (A_1 a A_4) representan básicamente al Paleógeno y afloran en la mitad oriental de la cuenca, al E del anticlinal de Campos de orientación submeridiana, mientras que las superiores (A_5 y A_6) representan al Neógeno y afloran en la mitad occidental de la cuenca al W de dicho anticlinal (fig. 1).

Los materiales englobados en la

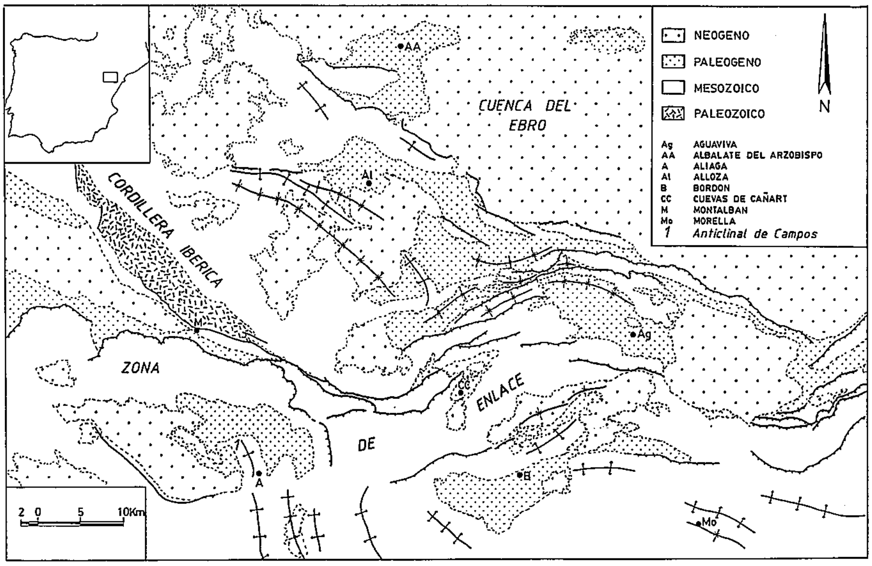

Fig. 1.—Esquema geológico de situación.

Fig. 1.—Geological location map.