paragénesis principal. Las rocas pertenecientes a este grupo se clasificarían como «tactitas de granate y piroxeno». Presentan una textura similar a la del tipo anterior, el piroxeno puede llegar a ser masivo, en mosaico de granos poligonales. El granate, zonado, corresponde al término andradítico, es de carácter porfidoblástico e incluye numerosos cristales de clinopx (augita), observándose en las zonas de borde una mayor abundancia de piroxenos orientados paralelamente al mismo, y que pueden llegar a reemplazar casi totalmente al granate. El anfíbol es poco abundante, verde, apenas pleocroico, y se desarrolla a expensas del piroxeno. Los minerales opacos (sulfuros y óxidos) están casi siempre englobados en el granate, aislados o en finos agregados siguiendo la zonación de éste.

Además de estos dos tipos de skarn bien representados, existen otras variedades de menor entidad, que son fundamentalmente silíceas y feldespáticas, en estas últimas se ha identificado mansfieldita asociada a los bordes de los sulfuros, mineral ya citado en el skarn de Carracedo (González-Montero, 1986); así como pequeñas drusas y filoncillos con cuarzo y fluorita.

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$\delta^{18}O$ of granites from the Western Central Iberian Massif, Spain

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RESUMEN

Se han determinado las relaciones isotópicas de oxígeno de varios tipos de granitos y migmatitas (nebulitas cordieríticas) en sectores occidentales del Macizo Central español. Granitos biotíticos y biotítico-anfibólicos muestran valores de $\delta^{18}O$ entre 9 y 10,5‰ (SMOW). Las nebulitas muestran una mayor variación (10-13‰). Los granitos con cordierita tienen valores intermedios (entre 9,8 y 10,5‰), sugiriendo la posibilidad de ser el resultado de la asimilación de nebulitas por el magma que origina los granitos biotíticos.

Palabras clave: *δO^{18}, granitos, nebulitas, asimilación, Macizo Central Ibérico.*

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Introducción

Oxigen isotopic data can be of great value in determining the possible protolith of igneous rocks, and also when studying processes subsequent to magma production, since magmas preserve the isotopic ratios of the source rocks, and fractional crystallization processes have a small effect on the oxigen isotopic composition of the resultant rocks (Faure, 1986). Consequently, it may be expected that in a granite series, the oxigen isotopic ratios reflect the protolith, unless hydrothermal o assimilation processes cause the modification of the original composition of the magma. Generally, $\delta^{18}O > +10‰$ SMOW is taken to indicate a substantial sedimentary component to the protolith (O'Neil & Chappel, 1977; Taylor, 1980).

In the present work, $\delta^{18}O$ data corresponding to different types of granites from the western areas of the Central Iberian Massif (fig. 1) are presented, in order to initiate the isotopic characterization of such granites. The preliminary data complement other information already known, and help to test previous hypothesis about some petrologic/petrogenetic aspects.

Analytical procedure

About 10 mg of finely powdered (200 mesh) whole-rock sample were

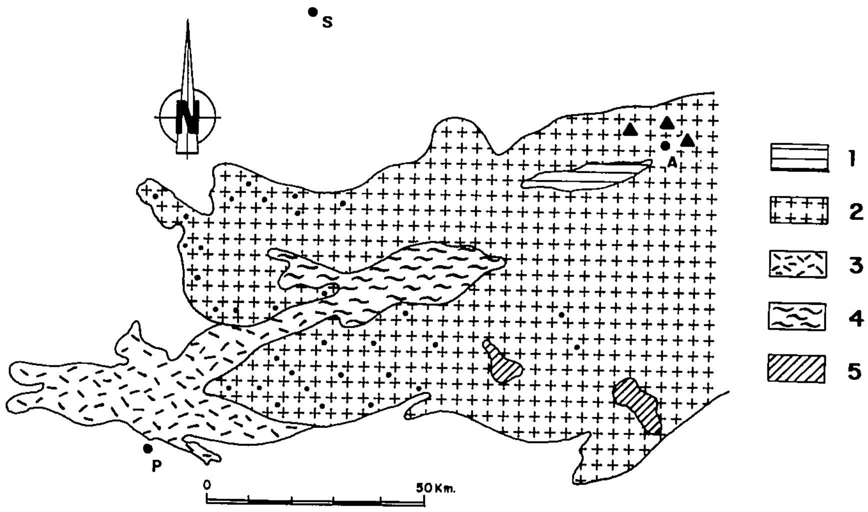

Fig. 1.—Geological scheme of the granites in the western Central Iberian Massif. Based on: Departamento de Petrología Univ. Salamanca (1983). 1: post-Paleozoic sediments. 2: biotite granites; dots: cordierite-bearing granites; triangles: amphibole-bearing granites. 3: biotite (±muscovite±sillimanite) granites. 4: cordieritic nebulites and heterogeneous anatectic granites. 5: metamorphic rocks. S: Salamanca. A: Avila. P: Plasencia.

used for oxygen isotopic analysis. O_2 was obtained through reaction with chlorine trifluoride (Clayton & Mayeda, 1963; modified by Borthwick & Harmon, 1982) during 15 hours at 690°C, and after prefluorination at 200°C to eliminate adsorbed water. The oxigen was converted to CO_2 by combustion in the presence of a graphite rod (Taylor & Epstein, 1962). Every sample was run at least twice.

Mass spectrometric analysis were performed in a triple collector, Nier-type mass spectrometer (V G Isogas, SIRA-10 model). Isotopic results are reported in the usual δ notation relative to SMOW (Craig, 1961).

$\delta^{18}O^0/_{00}$ SMOW values were measured with respect to an internal working standard calibrated against the standard NBS-28 (for which $\delta^{18}O$=9.60 relative to SMOW). Typical reproducibility is within±0.5 (1σ).

Rocks studied

— Cordieritic nebulites: these rocks, frequently found in the proximity of biotite granites and cordierite-bearing biotite granites (also as enclaves in those rocks) can be characterized by their great petrographic homogeneity and abundant prismatic cordierite. They show gradual transition to other less evolved migmatitic types (also rich in cordierite), and these to other rocks of lower metamorphic grade. The mineralogy is as follows: quartz, oligoclase, cordierite, alkali-feldspar and minor biotite, sillimanite (usually as fibrolite), apatite and, occasionally, andalusite.

— Amphibole-bearing biotite granites: they appear in variable size outcrops, always related to biotite granites, to which they show gradual transitions. Petrographically they vary from granodiorites to monzogranites. Essential minerals are quartz, andesine-oligoclase, biotite and alkali-feldspar. Amphibole (green hornblende), allanite and sphene, in variable proportions, are the main accesory minerals (Hernández *et al.*, 1982). Micrograngular, tonalitic-quartzdioritic enclaves are frequent, with biotite and amphibole as main minerals, and allanite and sphene as accesory ones.

— Biotite granites: similar to the last group, but without amphibole and allanite. Petrographically they also vary from granodiorites to monzogranites. Essential minerals are quartz, basic oligoclase-andesine, alkali-feldspar and biotite. They can occasionally have sphene. Microgranular, biotitic to biotitic-amphibolitic enclaves are frequent.

— Cordierite-bearing biotite granites: they appear in gradual transition with biotite granites, the difference being the presence of prismatic crystals of cordierite (pinitized) in variable proportions. As a matter of fact, it is sometimes very difficult to establish a precise limit between both granites. Mineralogy and other characteristics are very similar, except for the presence of scarce muscovite in the cordierite-bearing granites. Microgranular enclaves are frequently found.

Results and inferences

$\delta^{18}O^0/_{00}$ SMOW values are shown in table 1. The isotopic fields of the four groups of granites are shown in fig. 2. With due care, since the data set is limited, the following points are suggested:

a) The amphibole-bearing granites have values higher than those typical of directly mantle-derived rocks, but lower than rocks derived, by anatectic melting, from metasediments. It is then possible that these granites originated by melting of a crustal protolith, but excluding pure metasedimentary compositions as source-rocks (parent rocks).

b) The cordieritic nebulites have high isotopic values; this is concordant with an inmediate metasedimentary source-rock.

c) The isotopic ratios of the cor-

Table 1.—**1-3: cordieritic nebulites. 4-7: cordierite-bearing granites. 8-11: biotite granites. 12-14: amphibole-bearing granites**

nº	$\delta^{18}O^0/_{00}$	nº	$\delta^{18}O^0/_{00}$	nº	$\delta^{18}O^0/_{00}$
1	11,3	6	10,2	11	9,7
2	10,35	7	9,8	12	9,85
3	12,9	8	10,1	13	9,5
4	9,85	9	10,3	14	9,5
5	10,5	10	9,3		

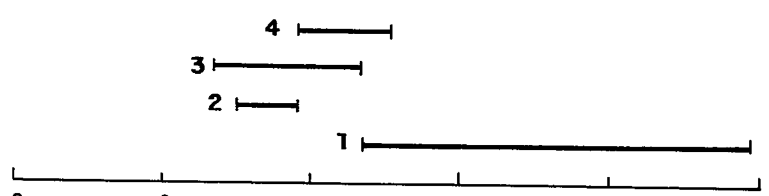

Fig. 2.—$\delta^{18}O^0/_{00}$ SMOW range of values. 1: cordieritic nebulites. 2: amphibole-bearing granites. 3: biotite granites. 4: cordierite-bearing granites.

dierite-bearing granites overlap the values of both biotite granites and nebulites. Consequently, the nebulites are not the source rocks of the cordierite-bearing granites, since if that were the case, higher $\delta^{18}O$ values might be expected in the granites.

d) $\delta^{18}O$ values of biotite granites overlap the values of amphibole-bearing granites, and are close to the lower limit of nebulites. This wide range of values is an indicator of compositional heterogeneity, whose origin may be the melting of isotopically heterogeneous rocks or the assimilation of host-rocks whose isotopic composition was different of that of the initial (original) granite magma. If we consider that cordierite-bearing granites are transitional, and that the range of values of cordierite-bearing granites is intermediate between nebulites and biotite granites, an assimilation hypothesis (biotite granites+nebulites) to produce cordierite-bearing granites seems to be the most credible. It is apparent that $\delta^{18}O$ studies are useful in undestanding the petrogenesis of these rocks.

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Contaminación por compuestos nitrogenados en el acuífero aluvial de la confluencia de los ríos Jarama y Henares: Origen y evolución

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ABSTRACT

The presence of nitrogen compounds in an aquifer is an evidence of pollution. In the aquifer studied, these compounds reach, in 50% of the analyzed samples, levels of nitrite, nitrate and ammonium too high for the water supply. Furthermore, a variation between the two samplings performed at different times of the year, due to the washing of the unsaturated zone, can be observed.

As main focus of pollution we can point out a stream collecting residual waters, the irrigation by means of the rivers Jarama and Henares water and the stabled livestock.

Key words: *hidrochemistry, pollution, groundwater, nitrite, nitrate, amonium.*

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Introducción

En la confluencia de los ríos Jarama y Henares se desarrollan formaciones cuaternarias de terrazas que constituyen, en conjunto, un acuífero aluvial formado por gravas, arenas y arcillas con un espesor saturado que oscila entre 3-7 m. Se considera un acuífero libre con una porosidad eficaz de 15-20% y una permeabilidad de 200-400 m/día, situándose el nivel freático próximo a la superficie del terreno a unos 4-5 m (Villarroya, 1977).

Por sus características este acuífero presenta una gran vulnerabilidad, ante procesos contaminantes, aunque también puede desarrollar un alto poder autodepurador.

En este trabajo se presenta un estudio del resumen realizado sobre este tema con ayuda de un proyecto de investigación del MOPU, DGMA en 1987.

El objetivo fundamental es determinar el estado actual en que se encuentra el agua subterránea en cuanto al contenido de compuestos nitrogenados y su evolución (nitratos, nitritos y amonio).

La zona estudiada está próxima a Torrejón de Ardoz, existiendo diversos focos potenciales de contaminación: riego por canales de derivación