Jadeitite Jade and Related Rocks from the Sierra del Convento Subduction Mélange (Eastern Cuba)

/JUAN CÁRDENAS-PÁRRAGA (1,*), ANTONIO GARCÍA-CASCO (1,2)

(1) Departamento de Mineralogía y Petrología, Universidad de Granada, Fuentenueva s/n. 18002, Granada (Spain)
(2) Instituto Andaluz de Ciencias de la Tierra (CSIC-UGR), Fuentenueva s/n. 18002, Granada (Spain)

INTRODUCTION.

The geological and gemological term "Jade" includes two different types of (quasi-) monomineralic rocks. One is amphibole jade, termed nephrite, a tremolite-actinolite rock with a felted, microcrystalline habit. The other is, pyroxene jade, termed jadeitite, a jadeite rock which varies from micro- to macro- crystalline textures. Jadeite jade is scarcer and more valuable than nephritic jade.

Jadeitite is formed in high-pressure subduction environments as a rare constituent within serpentinite-matrix tectonic mélanges. It is formed by fluid flow in veins over a wide range of pressure and temperature (P-T) conditions, from blueschist facies to eclogite facies (Harlow, 1994; Harlow and Sorensen, 2005; Sorensen et al., 2006; Harlow et al., 2008). Therefore, the study of jadeitites provides first hand insights into the chemical signature of released fluid and the role of slab dehydration, water-rock interactions and geochemical recycling in subduction zones, (Morishita et al., 2007; Sorensen et al., 2010).

Sorensen et al. (2010) cited eight localities where the geology of jadeitite bodies in serpentinite has been documented, however new jadeitite occurrences have been discovered recently in the Sierra del Convento Mélange, Cuba (García-Casco et al., 2009), Iran (Oberhänsli et al., 2007) and Río San Juan mélange, Dominican Republic (Schertl et al., 2007; Baese et al., 2007).

Jadeitite jade outcrops from Sierra del Convento mélange are described by Cárdenas-Párraga et al. (2010) and were interpreted as formed during subduction of Protocaribbean (García-Casco et al., 2009).

In this paper, we present a description of the petrographic and geochemical characteristics of the different varieties of jadeite jade and related rocks found in the Sierra del Convento mélange

GEOTECTONIC SETTING.

Petrologic and geochemical features of the Sierra del Convento mélange have been reported by García-Casco et al. (2008), Lázaro and García-Casco (2008) and Lázaro et al. (2009) together with a model developed for the formation and exhumation of the mélange which consists of several stages following counterclockwise P-T paths: (i) hot subduction of young oceanic lithosphere during 120-115 Ma; (ii) accretion of MORB-derived amphibolite to the upper plate mantle at ca. 115 Ma, when the amphibolites underwent fluid infiltration from dehydration of subducted serpentinite and wet-melting at ca. 15 kbar and 750 ºC, forming plagioclase-lacking residual amphibolite and peraluminous, K-poor, leucocratic tonalitic-trondhjemitic melts that segregated into veins, layers and agmatitic structures; (iii) relatively fast near-isobaric cooling at the upper plate mantle during 115-107 Ma, (iv) slow syn-subduction cooling and exhumation in the serpentinitic subduction channel during 107-70 Ma, and (v) fast syn-collision cooling and final exhumation during 70-65 Ma, when the melange was emplaced in its current structural position at the base of the Sierra del Convento mélange, in tectonic contact with the underlying volcanic arc Sierra del Purial Complex . García-Casco et al. (2009) suggested that formation of high temperature (640-575 ºC) jade varieties in the Sierra del Convento mélange may have to do with fluids released from crystallization of tonalitic-trondhjemitic melts at the upper plate mantle (stage ii above).

The mélange consists of a serpentinite matrix encompassing tectonics blocks of garnet-epidote amphibolite and tonalitic-trondhjemitic epidote gneiss, metamorphosed at high pressure and low to high temperature.

ANALYTICAL TECHNIQUES.

Whole-rock analyses of major and trace elements were carried out at the (Centro de Instrumentación Científica, CIC) in the University of Granada. Major element and Zr compositions were determined in PHILIPS Magix Pro (PW-2440) X-ray fluorescence (XRF). Trace elements, except Zr, were determined by ICP-MS.

The SEM images were obtained by a LEO 1430-VPSEM instrument, (CIC, Granada University). Mineral compositions were obtained by WDS with a CAMECA SX-100 microprobe (CIC, University of Granada). Software CSpace (Torres-Roldán et al, 2000) was used to calculate ternary and quaternary phase diagrams.
Elemental X-ray images were obtained with the same CAMECA SX-100 microprobe. The images were processed with software DWImager (Torres-Roldán and García-Casco, unpublished). For details see Blanco-Quintero et al. (2010 in press).

Isotope analyses were carried out at the University of Granada (CIC). Whole rock samples for Sr and Nd isotope analyses were digested in the same way as for ICP-MS analysis, using ultra-clean reagents and analyzed by thermal ionization mass spectrometry (TIMS) in a Finnigan Mat 262 spectrometer after chromatographic separation with ion exchange resins. For further information, see Lázaro and García-Casco (2008).

DISCUSSION AND CONCLUSIONS.

Jadeitite from the subduction mélange of the Sierra del Convento (eastern Cuba) occur closely associated with albitite, talc, and chlorite rocks and with tectonic blocks of variable composition

palabras clave: Jade Jadeititico, Alta Presión, Fluidos de Subducción, Caribe, Cuba Oriental.

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* corresponding author: cpjuan@correo.ugr.es

in a serpentinite matrix. Samples of jadeitite can be classified in two groups according to geochemical and petrographic characteristics. Group A is predominantly composed of jadeite and omphacite, with minor to trace amounts of other constituents such as epidote, biotite, albite, titanite and apatite. Group B is impure and mainly consists of jadeite, omphacite, albite and epidote, with minor to trace amounts of paragonite, muscovite, titanite and apatite (Fig. 1 and 2).

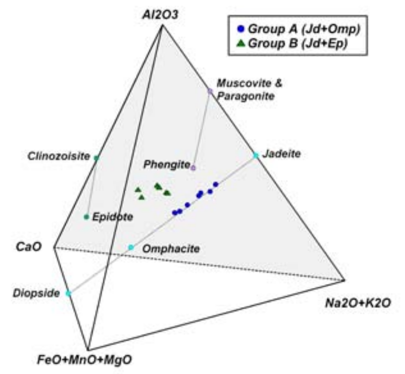

fig 1. *Quaternary diagram ACFN (molar).*

Textures (including oscillatory zoning) of group A jadeitites (Fig. 2a) show evidence of crystallization from fluids in veins triggered upon episodic infiltration of fluids at >550 ºC.

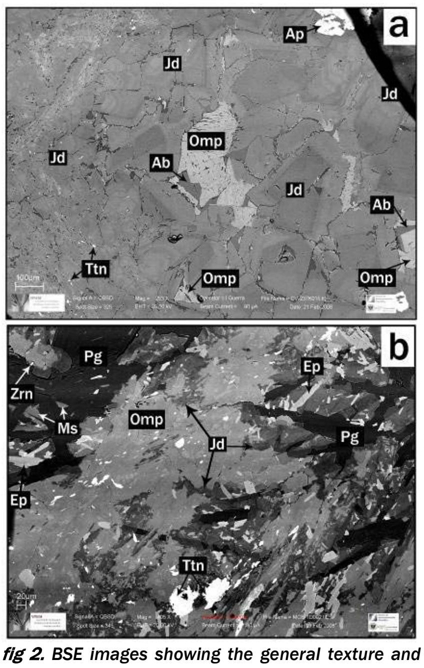

fig 2. *BSE images showing the general texture and mineralogy of each group of jadeitites.*

In Both groups display REE abundances similar to those of pegmatites of the Sierra del Convento mélange. These and other geochemical characteristics suggest a genetic link between pegmatitic H_2O-rich melts and jade-forming fluids deep in the subduction channel.

The relatively high temperature of formation of jadeitite and the early Cretaceous SHRIMP zircon $^{206}Pb/^{238}U$ ages of 105-110 Ma from jadeitite, corresponding to the isobaric (at ca. 15 kbar) cooling stage of trondhjemitic liquids of the mélange, strengthen this view. We suggest two types of pegmatite-derived fluids involved in the formation of jadeitite jade rocks: a fluid rich in K, Ba, and Rb with a strong sedimentary component evolved from K-rich pegmatites (group B), and a depleted fluid with a strong mantelic component evolved from K-poor pegmatites (group A), as indicated by Rb/Sr and Sm/Nd isotopes. This new occurrence of jadeite in Cuba opens important perspectives for archaeological studies of pre-Columbian jade artifacts in the Caribbean region.

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REFERENCES.

Baese, R., Schertl, H.P., Maresch, W.V. (2007): Mineralogy and petrology of Hispaniolan jadeitites: first results. In: Martens U., García-Casco A. (eds) High-pressure belts of Central Guatemala: the Motagua suture and the Chuacús Complex. IGCP 546 Special Contribution, 1. http://www.ugr.es/~agcasco/igcp546/>>Activities>>Guatemala2007>>Abstracts

Blanco-Quintero, I.F., García-Casco, A., Rojas-Agramonte, Y., Rodríguez-Vega, A., Lázaro, C., Iturralde-Vinent, M. A. (2010): Metamorphic evolution of subducted hot oceanic crust, La Corea mélange, Cuba: American Journal of Science, in press.

*Cárdenas-Párraga, J., García-Casco, A., Núñez-Cambra, K., Rodríguez-Vega, A., Blanco-Quintero, I.F., Harlow, G.E., Lázaro, C. (2010): Jadeitite jade occurrence from the Sierra del Convento mélange (eastern Cuba). Boletín de la Sociedad Geológica Mexicana, **62**, 1, 199-205.*

*García-Casco, A., Lázaro, C., Rojas-Agramonte, Y., Kröner, A., Torres Roldán RL, Núñez-Cambra, K., Millán, G., Neubaurer, F., Blanco-Quintero, I.F (2008): Partial melting and counterclockwise P-T path of subducted oceanic crust (Sierra del Convento, E Cuba). J. Petrol., **4**, 129–161.*

*García-Casco, A., Rodríguez-Vega, A., Cárdenas-Párraga, J., Iturralde-Vinent, M.A., Lázaro, C., Blanco-Quintero, I.F., Rojas Agramonte, Y., Kröner, A., Núñez-Cambra, K., Millán, G., Torres-Roldán, R.L., Carrasquilla, S. (2009): A new jadeitite jade locality (Sierra del Convento, Cuba): first report and some petrological and archaeological implications. Contributions to Mineralogy and Petrology, **158**, 1-16.*

*Harlow, G.E. (1994): Jadeitites, albitites and related rocks from the Motagua Fault Zone, Guatemala. Journal of Metamorphic Geology, **12**, 49–68.*

*Harlow, G.E. & Sorensen, S.S. (2005): Jade (nephrite and jadeitite) and serpentinite: metasomatic connections. International Geology Review, **47**, 113–146.*

Harlow, G.E., Sorensen, S.S., and Sisson, V.B. (2008): Jade Deposits, in: "Geology of Jade Deposits". L.A. Groat, ed. Mineralogical Society of Canada Short Course Series V, p. 37, 207–254.

*Lázaro, C. & García-Casco, A. (2008): Geochemical and Sr-Nd isotope signatures of pristine slab melts and their residues (Sierra del Convento mélange, eastern Cuba). Chem. Geol., **255**, 120–133.*

*Lázaro, C., García-Casco, A., Neubaurer, F., Rojas-Agramonte, Y., Kröner, A., Iturralde-Vinent, M.A. (2009): 55-million-year history of oceanic subduction and exhumation in the northern edge of the Caribbean plate (Sierra del Convento mélange, Cuba). J. Metamorph. Geol., **27**, 19-40.*

*Morishita, T., Arai, S. Ishida, Y. (2007): Trace element compositions of jadeite(+ omphacite) in jadeitites from the Itoigawa–Ohmi district, Japan: Implications for fluid processes in subduction zones. Island Arc, **16**, 40–56.*

*Oberhänsli, R., Bousquet, R., Moinzadeh, H., Moazzen, M., Arvin, M. (2007): The field of stability of blue jadeite: a new occurrence of jadeitite at Sorkhan, Iran, as a case study. Can. Min., **45**, 1501–1509.*

Schertl, H.P., Krebs, M., Maresch, W.V., Draper, G. (2007): Jadeitite from Hispaniola: a link between Guatemala and Antigua? 20th Colloquium on Latin American Earth Sciences, Kiel, Germany, Abstract Volume, 167–168.

*Sorensen, S.S., Harlow, G.E., Rumble, D. (2006): The origin of jadeitite-forming subduction-zone fluids: CL-guided SIMS oxygen-isotope and trace-element evidence. American Mineralogist, **91**, 979–996.*

Sorensen, S.S., Sisson, V. B., Harlow, G.E., Avé Lallemant, H.G. (2010): Element residence and transport during subduction-zone metasomatism: evidence from a jadeitite-serpentinite contact, Guatemala. International Geology Review, First published on: 28 April 2010)

*Torres-Roldán, R. L., García-Casco, A., García-Sánchez, P. A. (2000): CSpace: An integrated workplace for the graphical and algebraic analysis of phase assemblages on 32-bit Wintel platforms: Computers and Geosciences, **26**, 779-793.*