A multi-isotopic and trace elemental approach to provenance Caribbean greenstone artefacts in an essentially non-destructive way:
Implications for pre- and post-colonial exchange and mobility networks

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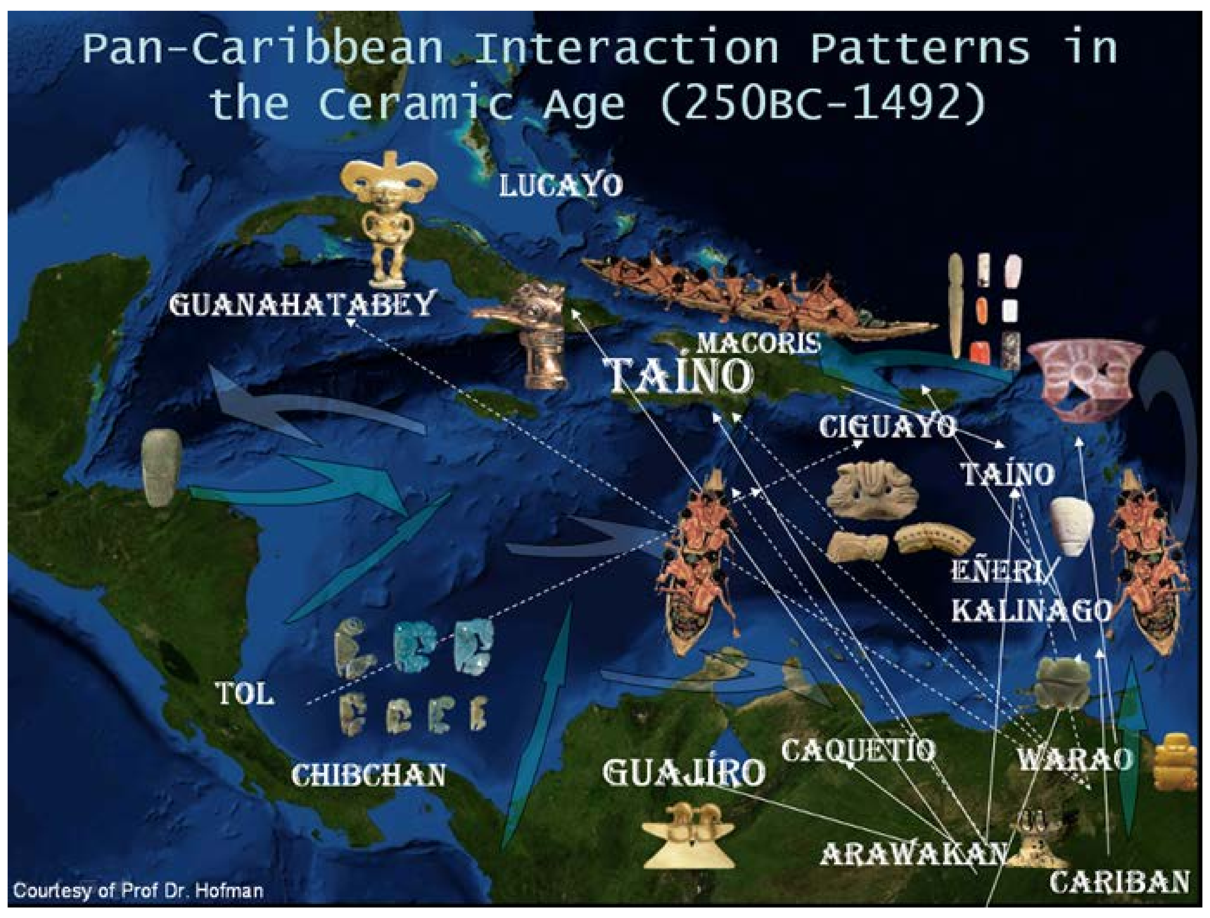
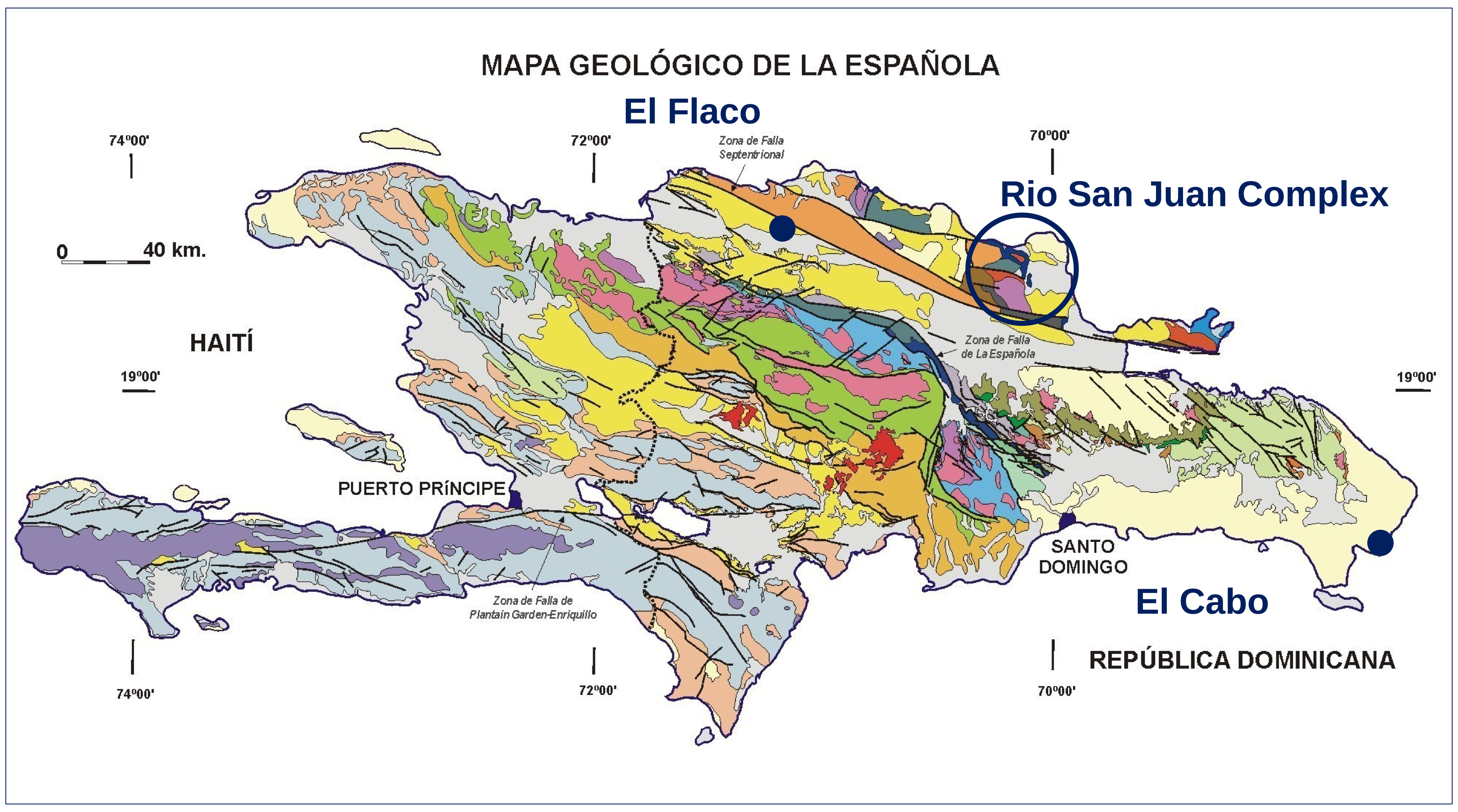


INTRODUCTION

The Nexus 1492 project investigates the impacts of colonial encounters in the Caribbean in the period AD 1000 – 1800. Throughout the Caribbean, greenstones were used to manufacture artefacts, including figurines, spiritual items and jewellery, as well as tools such as axes. Whilst the metamorphic complexes serving as raw materials have restricted occurrences, the greenstone artefacts are found throughout the Caribbean region establishing transport up to 100's km.

This research aims to provenance greenstone artefacts by using a combination of trace element and multi-isotopic analyses obtained on sub-mg samples. This preliminary (destructive) study serves as basis for 'non-destructive' techniques to be applied.

In order to understand circum-Caribbean trade, several groups are characterising the mineralogy, major and trace element and isotopic compositions of the principle metamorphic complexes in the Greater Antilles to provide the database with which to determine artefact provenance. Sampling of artefacts in European and Caribbean museum collections will be carried out using the portable laser device.



JADEITITE AXES

Samples were taken from jadeitite axe fragments excavated at the El Cabo site (AD 800-1504) in the SE Dominican Republic and the El Flaco site (pre-columbian, AD ?) in the NW Dominican Republic. The lithologies surrounding El Cabo are limestones, the geology of the El Flaco region consists of siliciclastic lithologies including limestone.

Jadeitite is an almost monomineralic rock containing jadeite pyroxene ($NaAlSi_2O_6$) formed associated with subduction to lawsonite-eclogite to blueshist facies P-T conditions. Jadeitite form either by direct precipitation from Na-Al-Si rich hydrous fluid (P-type) in veins or by metasomatic replacement (R-type) of precursor mafic-acid rocks. Within the Caribbean region jadeitite outcrops are known in Guatemala, Cuba and the Dominican Republic. The jadeitites occur in fault zone mélanges with a serpentinite matrix, along with variably metamorphosed and metasomatised oceanic crustal rocks (Harlow et al., 2003; García-Casco et al., 2009; Schertl et al., 2012).

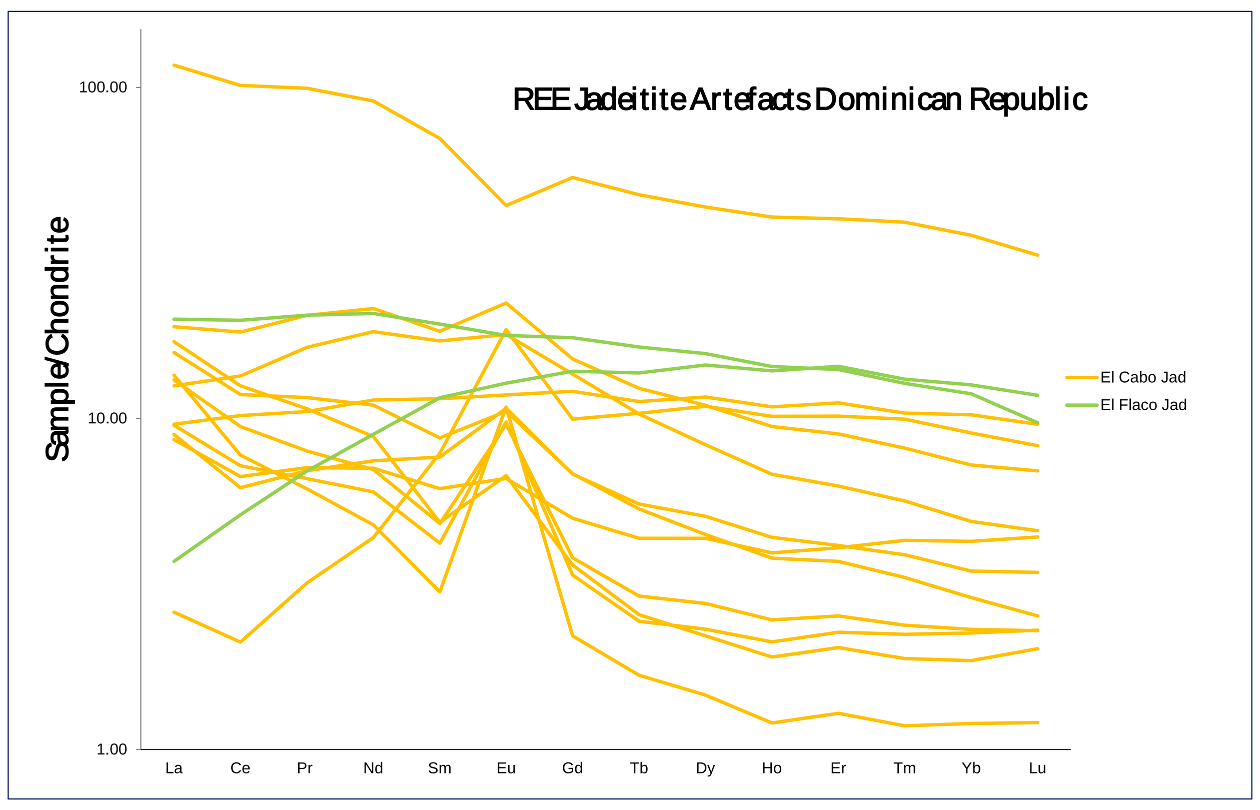
METHODS

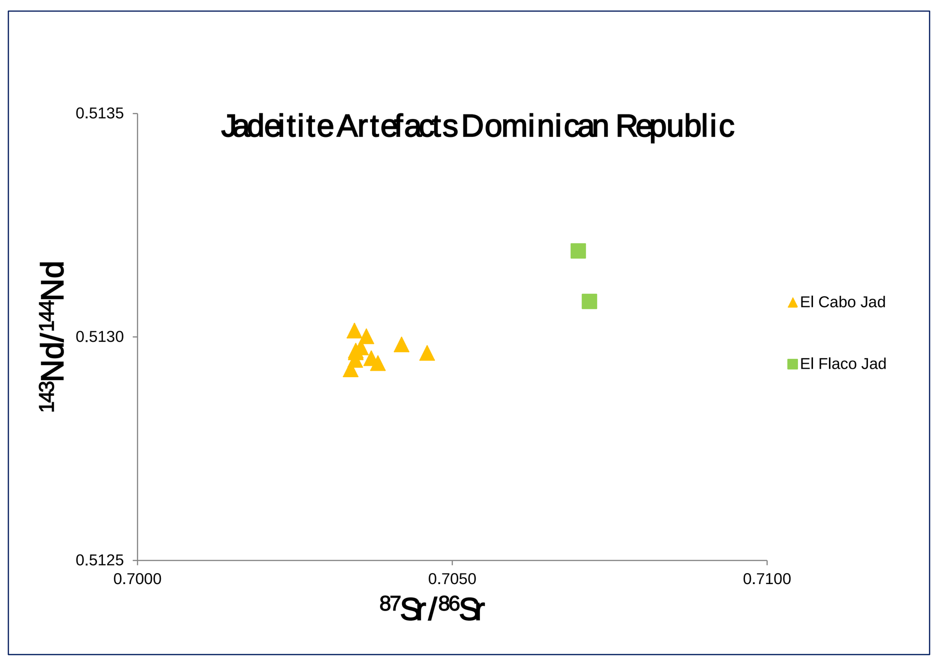
Samples of jadeitite axes from El Cabo and El Flaco were crushed and digested for separation of Sr, Nd and Pb by ion exchange chromatography. Sr, Nd and Pb isotope compositions were determined by multi collector mass spectrometry. Trace element contents were determined on small sample aliquots by ICPMS.

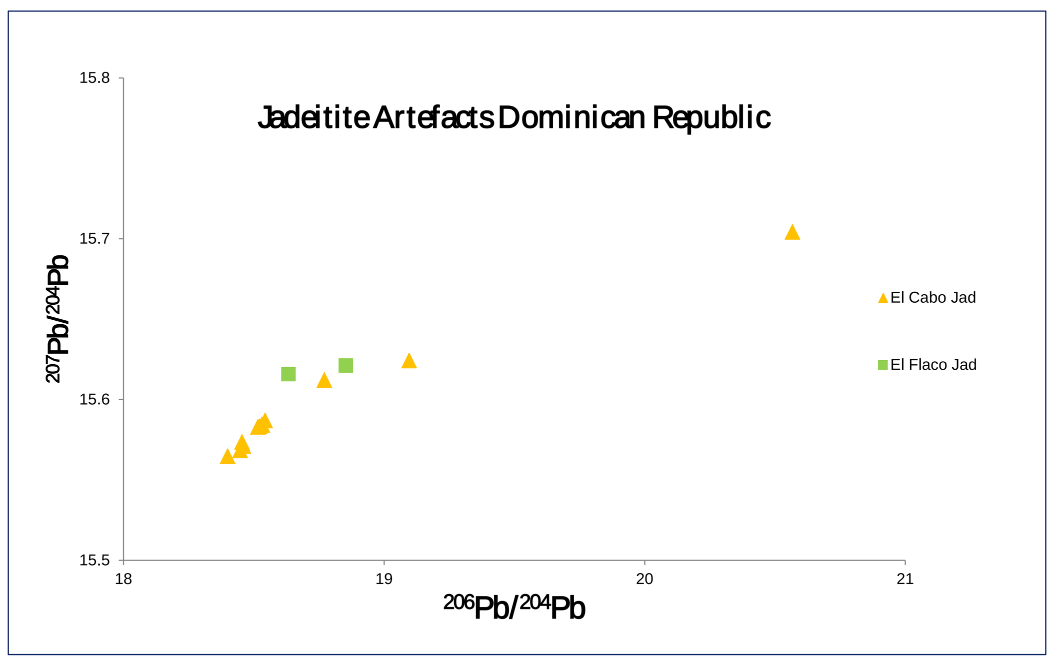
PRELIMINARY RESULTS

All samples record only minor fractionation among HREE but there is marked variation in the slope of the M and LREE. El Cabo jadeitite fragments vary from LREE depleted to LREE enriched covering the range observed for samples from El Flaco (La/Yb ratio varies between 0.94 to 11.27). Hence no distinction can be made based on the ICPMS data.

Jadeitite axe fragments from the El Flaco site have $^{87}Sr/^{86}Sr$ ratios with little variation (0.70718 to 0.70701), and show small variation in $^{143}Nd/^{144}Nd$ ratios (0.51308 to 0.51319). The El Cabo jadeitite implements, by contrast, show a wider range in $^{87}Sr/^{86}Sr$ from 0.70337 to 0.70460 and also limited variation in the $^{143}Nd/^{144}Nd$ ratios (0.51294 to 0.51300). Notably their Sr isotope compositions differ from the El Flaco jadeitites. Pb isotope compositions for El Cabo jadeitites overlap the range of the El Flaco samples.





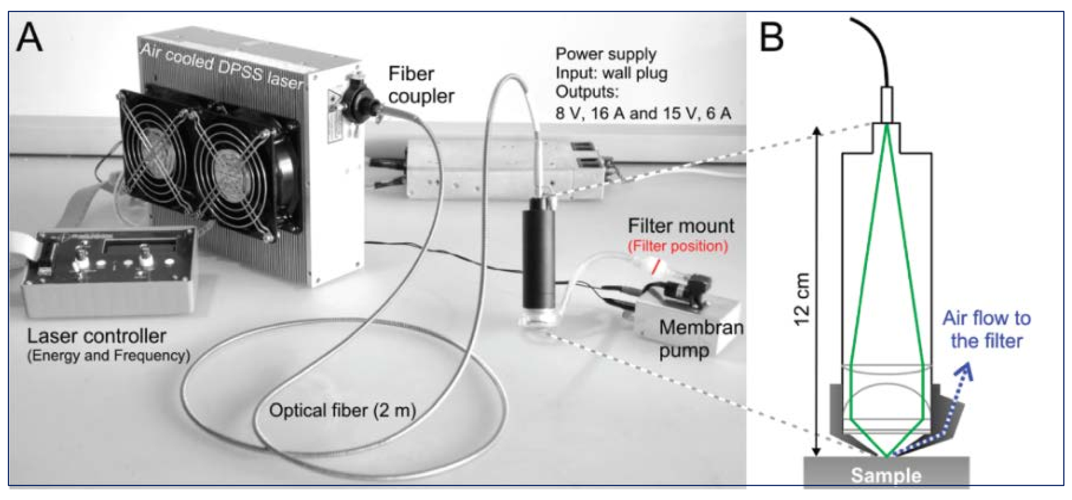


PRELIMINARY CONCLUSIONS

Preliminary results show that combined trace elemental and multi-isotopic analyses discriminate greenstone artefacts. Sr and isotope compositions from the El Flaco Site and the El Cabo site are significantly different. As jadeitite can be found in the Rio San Juan Complex in the NE Dominican Republic it was assumed that this complex served as the source for both sites. The heterogeneity of the Rio San Juan jadeitite Complex is being examined to establish if the observed differences in the artefacts reflect local variation in provenance or if other known sources like Cuba or Guatemala have to be considered.

PORTABLE LASER ABLATION SAMPLING DEVICE

In order to obtain essentially non-destructive sampling from artefacts *in situ* in museums, a portable laser device has been modified from Glaus et al., 2012; (Fig. A,B,). The laser beam results in an ablation crater of 50-100 µm in width and depth and a mass removal of approximately 0.5 µg for 1000 pulses. The ablated material is transported by an air flow onto a filter. Filters can be taken back to the laboratories for further analyses. A miniaturised multi-isotopic technique has been set-up to measure sub-nanogram amounts of strontium (Sr), neodymium (Nd) and lead (Pb).



Glaus, R., Koch., J., Günther, D., (2012): Portable Laser Ablation Sampling Device for Elemental Fingerprinting of Objects Outside the Laboratory with Laser Ablation Inductively Coupled Plasma Mass Spectrometry. Anal. Chem., 84, 5358−5364.

Harlow, G.E., Sisson, V.B., Ave Lallemant, H.G., Sorensen, S.S., Seitz, R., (2003): High-pressure, metasomatic rocks along the Motafua Fault Zone, Guatemala. Ofioliti, 28(2), 115-120.

García-Casco , A., Rodriguez Vega, A., Cardenas Parraga, J., Iturralde-Vinent, M.A., Lazaro, C., Blanco Quintero, I., Rojas Agramonte, Y., Kroener, A., Nunez Cambra, K., Millan, G.,Torres-Roldan , R.L., Carrasquilla, S., (2009): A new jadeitite jade locality (Sierra del Convento, Cuba): First report and some petrological and archeological implications. Contrib Mineral Petrol.,158, 1–16.

Schertl, H.-P., Maresch, W.V., Stanek, K.P., Hertwig, A., Krebs, M., Baese, M., Sergeev, S.S., (2012): New occurrences of jadeitite, jadeite quartzite and jadeite-lawsonite quartzite in the Dominican Republic, Hispaniola: petrological and geochronological overview. Eur. J. Mineral. 24, 199–216.

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