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Research paper

# Origin of carbon in fumarolic gas from island arcs

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## Abstract

We have measured

$^3\text{He}^4\text{He}$  ratios,  $\delta^{13}\text{C}$ -values and

$\text{CO}_2^3\text{He}$  ratios of fumaroles and hot spring gases in three volcanic areas in Japan. The

$^3\text{He}^4\text{He}$  ratios,  $\delta^{13}\text{C}$ -values and

$\text{CO}_2^3\text{He}$  ratios vary from  $0.05 R_{\text{atm}}$  to  $9.7\%$  and from  $7.74 \times 10^9$  to

$1.18 \times 10^{11}$ , respectively. Based on these data and those in the literature, we present the

first quantitative estimates of the upper mantle, sediment and limestone including slab

components in  $\text{CO}_2$  of volcanic and hydrothermal fluids from subduction zones. Taking

compiled C isotopic data of limestone and organic sediment assuming that the

$\text{CO}_2^3\text{He}$  ratio and  $\delta^{13}\text{C}$ -value of mid-ocean ridge basalt (MORB) are representative of

the upper-mantle component, and that later isotopic and elemental fractionations are

minimal, it is possible to deconvolve each fraction of C on the basis of simple mixing

equations. Up to 20% of the carbon in high-temperature volcanic gases in subduction zones is derived from a MORB-type source, while the major fraction of the gases is attributable to CO<sub>2</sub> produced by decarbonation of subducted marine limestone and slab carbonate.



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