# Marine terrace soils along the west coast of North America: a weathering archive?

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Soil chronosequences provide a framework for understanding the influence of time on soil and ecosystem properties. To simultaneously examine how landscapes of different ages will respond to future climate shifts, we can compare landscapes across age and climate. North America's west coast has a significant precipitation gradient (wet in the north, dry in the south), supporting a gradation of ecosystems from northern temperate rainforests, through mixed forests, semi-arid Mediterranean chaparral and southern desert ecosystems. Marine terraces occur up and down the west coast of North America; each flight of stair-like terraces is a chronosequence. The soils of coastal marine terraces in the west provide a "climosequence of chronosequences" ideally suited to examine the interactions of landscape age and climate on soil and ecosystem resistance and resilience to climate change.

Building on work at the Santa Cruz (CA) marine terraces, we are developing a network of terrace chronosequences along the west coast. Past work at the Santa Cruz terraces examined soil development and elemental cycling in detail. Ongoing work on these terraces includes field, laboratory, and modeling efforts to understand carbon cycling. Our future work will extend the methods we have refined at Santa Cruz to other well-established North American marine terrace chronosequences.

We hypothesize that soil properties, processes, and rates on west coast terraces might be meaningfully assigned to climate zones as well as age of soil formation. Comparison of results from different marine terrace chronosequences will require addressing several important questions linking the paleohistory of soil formation with contemporary soil properties: The central question is what memories of past climate do soils possess, and how can we measure them? This problem requires multidisciplinary discussions, inspiration, and work. Soil properties that turn out to be indicative of distinctive climate-ecosystem combinations are potentially useful as references for judging the timing and extent of change in other soils. For example, data from the Santa Cruz chronosequence suggests that the isotopic fractionation of Fe may indicate past chaparral or forested ecosystems in soils currently occupied by coastal prairies. We hope to establish which soil properties change most with climate, and by utilizing multiple time sequences of soils, to bracket the timing of the changes. In this way the potential of naturally occurring archives recorded in marine terraces along North America's west coast can be used to address questions about future effects from climate change.

# The case of p-Process $^{180}$W heterogeneities in Iron Meteorites

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## Introduction

For most elements, in particular for r- and s-process isotopes, the abundances of non-radiogenic isotopes appear to be fairly homogeneous in the early solar system. This is likely to reflect efficient homogenisation of materials in the protoplanetary disk. However, a notably small number of elements are reported to display distinct anomalies, interpreted as being nucleosynthetic. Due to their low abundances, only few studies so far have measured heavy p-process isotopes [e.g. 1]. The low abundances of these neutron deficient nuclides reflect their particular formation conditions [e.g. 2]. Our recently presented $^{180}$W measurements in iron meteorites reported clearly resolvable anomalies of up to ~+700ppm [3], interpreted to be of nucleosynthetic origin. However, recent studies [4] argued that such non-radiogenic stable W isotope anomalies may reflect analytical artifacts, resulting from molecular interferences. We therefore conducted replicate measurements of the Cape York IIIAB iron meteorite using modified analytical protocols.

## Methods

Tungsten measurements were conducted using the Neptune multicollector ICP-MS at the University Bonn that is equipped with high sensitivity $10^{12}$ Ohm amplifiers for measuring $^{180}$W and the $^{178}$Hf interference monitor. Measurements were run in low- and high resolution and by using different sampler cones, including so-called "Jet Cones" with wider aperture. About 6g of Cape York metal was dissolved and loaded onto conventional anion exchange columns. Following modified elution procedures, W was purified from the 6 g sample, and AMES standard solutions were processed as well. For multiple measurements of AMES W standard solutions we obtained external reproducibilities of ±80 ppm (2σ r.s.d). $^{178}$Hf intensities were typically an order of magnitude lower than required for accurate $^{180}$Hf interference corrections.

## Results and Discussion

Our preliminary results confirm a clearly resolvable $^{180}$W anomaly for Cape York. Using standard and Jet-cone setups we obtained $^{180}$W values of about ~+350ppm and typical $^{182}$W and $^{184}$W signatures in low- and medium resolution. In high resolution we could reproduce the $^{180}$W excess using standard cones, but an offset of as much as 4500ppm using Jet-cones, which can be attributed to anomalous mass bias behaviour potentially reflecting matrix effects. Terrestrial W isotope compositions obtained with standard cones for all AMES W solutions which were processed during column chemistries and for terrestrial metals from reduced basalts provide further support for a nucleosynthetic origin of the measured anomalies.

## Conclusions

Evidence for $^{180}$W heterogeneities in iron meteorites is provided from (1) systematic excesses in $^{180}$W between different iron meteorite groups [3], (2) offsets from the respective group averages for long exposed meteorites due to cosmogenic burn-out of $^{180}$W [3]) and (3) analytical evidences presented here. Our results call for further studies evaluating mass bias behaviour in modified ("Jet Cone") interface devices in MC-ICPMS systems.

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