



INVESTIGATING FREQUENCY AND ORIGIN OF TAR RESIDUES ON CRYSTAL COVE STATE PARK

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Project Goals

Goal 1 - Establish baseline frequency, size distribution and weathering status of tarballs at Crystal Cove State Park.

Goal 2 - Identify potential sources of naturally occurring tarballs and $\delta^{13}\text{C}$ fidelity at Crystal Cove State Park.

Background and Methods

Introduction

- Crude oil residues, also referred to as tarballs (due to their size) are often found along the coastline of Crystal Cove State Park (Fig 1).
- In Southern California, tarballs naturally occur because of marine natural oil seepages.
- Tarballs can also result from oil spills from offshore pipelines or international tankers.
- Understanding tarball occurrence patterns can help to decipher between natural frequencies and anthropogenic introductions.
- Carbon stable isotope signatures can help identify natural vs anthropogenic sources of tar because they differ according to the source of the crude oil.
- Past studies have found very consistent carbon stable isotope ratios in the Southern California bight (Fig 7). But there are no studies of Orange County beach areas.

Methods

- All data & samples from Crystal Cove State Park, Orange Co., CA
- Four sampling dates spanning 1.4-3.0 km of beach
- All tarballs found within 4 m of wrack line were measured for size, weather class, and GPS location
- Weathering classes (young, moderate, old) of individual tarballs were based on viscosity and apparent degradation.
- Sizes classes (Table 1) were based on ellipse area calculated from max width and perpendicular width.



Figure 1. Closeup of crude oil residue (tarball) on Crystal Cove State Park.

Size Class	1	2	3	4	5
Area (mm ²)	150 - 850	851 - 1550	1551 - 2250	2251 - 2950	2951+

Table 1. Ranges of ellipse areas for each size class category (1-5).

- A subset of tarballs were sampled for carbon stable isotope ($\delta^{13}\text{C}$) analysis
 - 1-2 mg analyzed in triplicate using a Cavity Ring-Down Spectroscopy system in the Loyd Geochemistry Lab (CSUF).

Goal 1 Conclusions

Tarballs are Infrequent, Moderately Weathered and Relatively Small at Crystal Cove State Park

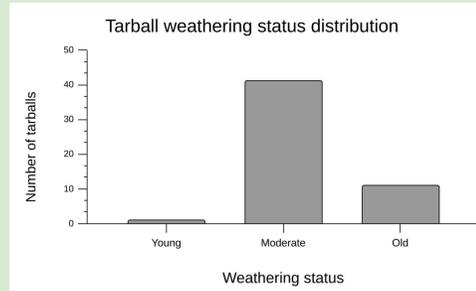


Figure 2. Frequency of tarballs of each weathering status. All tarballs were recorded within 4 m of the wrack line, across approx. 5 km of Crystal Cove State Park coastline.

Weathering can sometimes be used as an estimation of age; the older the tarball is, the more weathered it will appear.

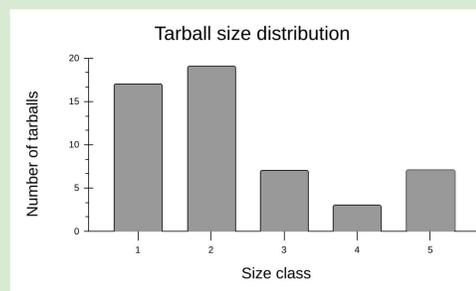


Figure 3. Frequency of tarballs in each size class (Table 1). All tarballs were recorded within 4 m of the wrack line, across approx. 5 km of Crystal Cove State Park coastline.

Larger tarballs are generally indicative of an oil spill because of the quantity of oil being released at once, whereas smaller tarballs can be indicators of natural oil seepage.

Results

- Tarball weathering status was primarily moderate (Fig 2), but all classes were represented.
- Tarball size distribution was largely skewed towards size classes 1 and 2 (Fig 3).
- Density of beach tarballs over four sampling periods ranged from 9.3 per km to 17.5 per km.

Community Science Program

- This project will establish a long-term monitoring program at Crystal Cove State Park to track tarball distributions and understand their natural patterns in the absence of any impactful oil spills; engaging students and community members in conservation initiatives.



Figure 4. LBHS students working together to take measurements and observations of a tarball encountered at Crystal Cove.

Goal 2 Conclusions

Tarballs at Crystal Cove Appear to Originate From the Local Monterey Formation Seeps; Tarball Size Class and Weathering Do Not Alter $\delta^{13}\text{C}$ Signature

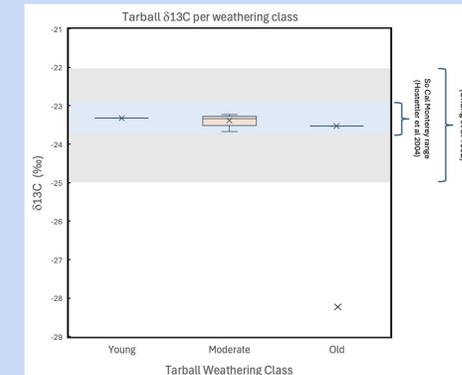


Figure 5. Mean stable carbon isotope ratios (‰) based on degree of weathering. Shaded area is the known range of crude oil from the Miocene Monterey Formation, broadly (gray, Chung et. al. 1992) and locally (blue, Kvenvolden & Hostettler 2004).

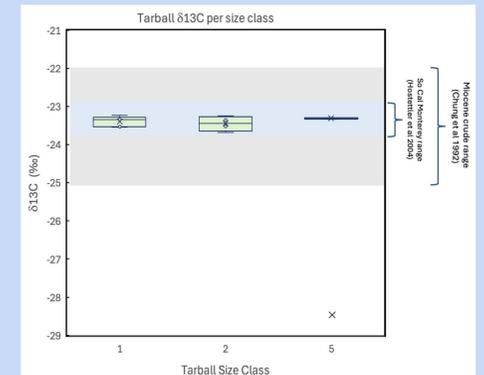


Figure 6. Mean stable carbon isotope ratios (‰) based on size class. Shaded area is the known range of crude oil from the Miocene Monterey Formation, broadly (gray, Chung et. al. 1992) and locally (blue, Kvenvolden & Hostettler 2004).

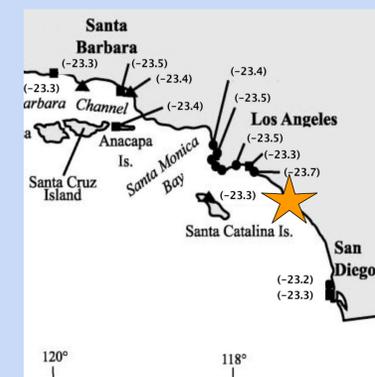


Figure 7. Stable carbon isotope ratios (‰) of beach tarball samples previously collected in Southern California. Data and map adapted from Kvenvolden & Hostettler 2004. Star represents the Crystal Cove collection area (see Fig 8).



Figure 8. Stable carbon isotope ratios (‰) of beach tarball samples collected along Crystal Cove State Park.

Results

- All but one tarball $\delta^{13}\text{C}$ value fell within the range of crude oil from the Miocene Monterey Formation (Figs 5, 6) and previous local studies (Fig 7).
- One sample exceeded all known values for Monterey crude (Figs 5, 6). Its origin is under investigation.
- Tarball $\delta^{13}\text{C}$ range was < 0.5 ‰ along the 5 km Crystal Cove beach transect
- Mean $\delta^{13}\text{C}$ values across all tarball size classes were indistinguishable from each other (Fig 5), as were values among weathering groups (Fig 6).

Works Cited:



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