Metallurgical & Corrosion Evaluation of the USS Arizona Research Experience for Undergraduates 2009 (REU)



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Objectives

- Characterize steel taken from the U.S.S. Arizona.
- Present findings on experiments performed on selected pieces from U.S.S. Arizona's hull.
- Experiments include microstructural, chemical, and corrosion susceptibility analysis.
- This information will provide understanding into the metallurgical practices of the time when the ship was built.
- May provide information leading to better preservation of the ship and others like it.

Metallurgical Analysis

- Three varieties of plate were analyzed as well as a rivet.
- A photograph showing the plate and rivet is shown in Figure 1.



Figure 1: Photograph of the selected steel pieces from the U.S.S. Arizona at Waipio Point. Left: Plate A-1. Top: Plate A-2. Right: Plate A-3. **Bottom: Rivet.**



Figure 2: Micrograph of Plate A-1. 100 X.

Sample	Area Percent Pearlite	Area Percent Ferrite	Calculated Weight Percent Carbon Content
Rivet	22	78	0.18
Plate A-1	11	89	0.1
Plate A-2	NA	NA	NA
Plate A-3	28	72	0.23

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• In Figures 2, 3, 4, and 5, the respective micrographs of the plate and rivet taken with an optical microscope are shown.



Figure 3: Micrograph of Plate A-2. 500 X.



Figure 4: Micrograph of Plate A-3. 100 X

• Core samples recently taken from the U.S.S. Arizona's hull were also analyzed with an optical microscope.

• A photograph of the core samples is shown in Figure 6.

• The core samples were compared to the other specimens.

• If the core sample has similar microstructure, it can be assumed that it also has similar chemistry and corrosionsusceptibility given the same conditions.



Figure 6: Photograph showing the core samples taken from the U.S.S. Arizona.

• A chemical analysis for the carbon content of the steel was performed on the selected samples of plate and rivet.

• The results of the carbon content analysis are shown in Table 1.

Table 1: Results of the carbon content analysis.

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Figure 5: Micrograph of the Rivet. 200 X.

Corrosion Rate Analysis

- Corrosion rate data was obtained using testing.
- The tests were done within specifications of ASTM, G-61.
- The results of the corrosion analysis are shown in Table 2, and the rates are given in mils (thousandth of an inch) per year.

Sample Type	Corrosion Rate (mpy)
Plate A-1	4
Plate A-2	2.3
Plate A-3	5.2
Rivet Head	5.3
Rivet Shaft	2.1

Broader Impact

- This information will allow the National Park Service to make better informed
- Preserving the U.S.S. Arizona will ensure that the sailors that lost their lives on the ship will continue to be remembered and honored for their sacrifice for freedom.
- This information will also allow others to make better informed decisions in preserving other submerged ships as well.



PAP (potentiodynamic anodic polarization)

Table 2: Corrosion rates of selected U.S.S. Arizona samples.

decisions in preserving the U.S.S. Arizona.