



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.

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

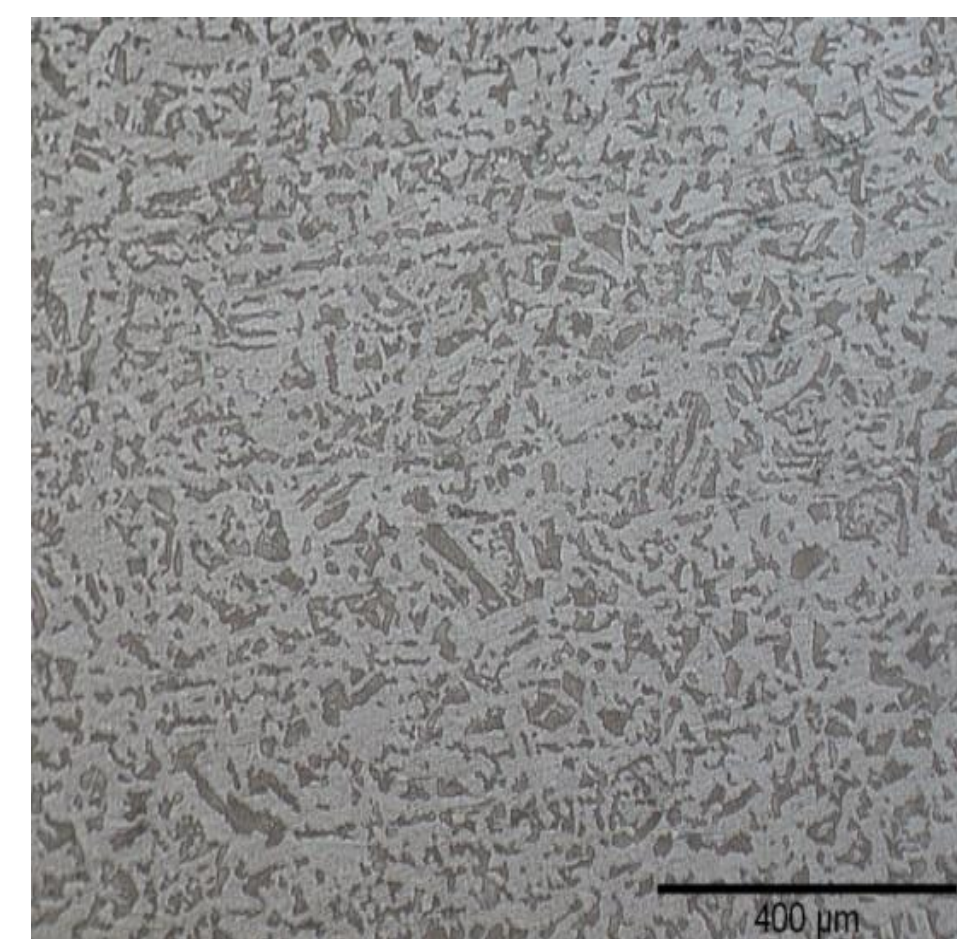


Figure 2: Micrograph of Plate A-1. 100 X.

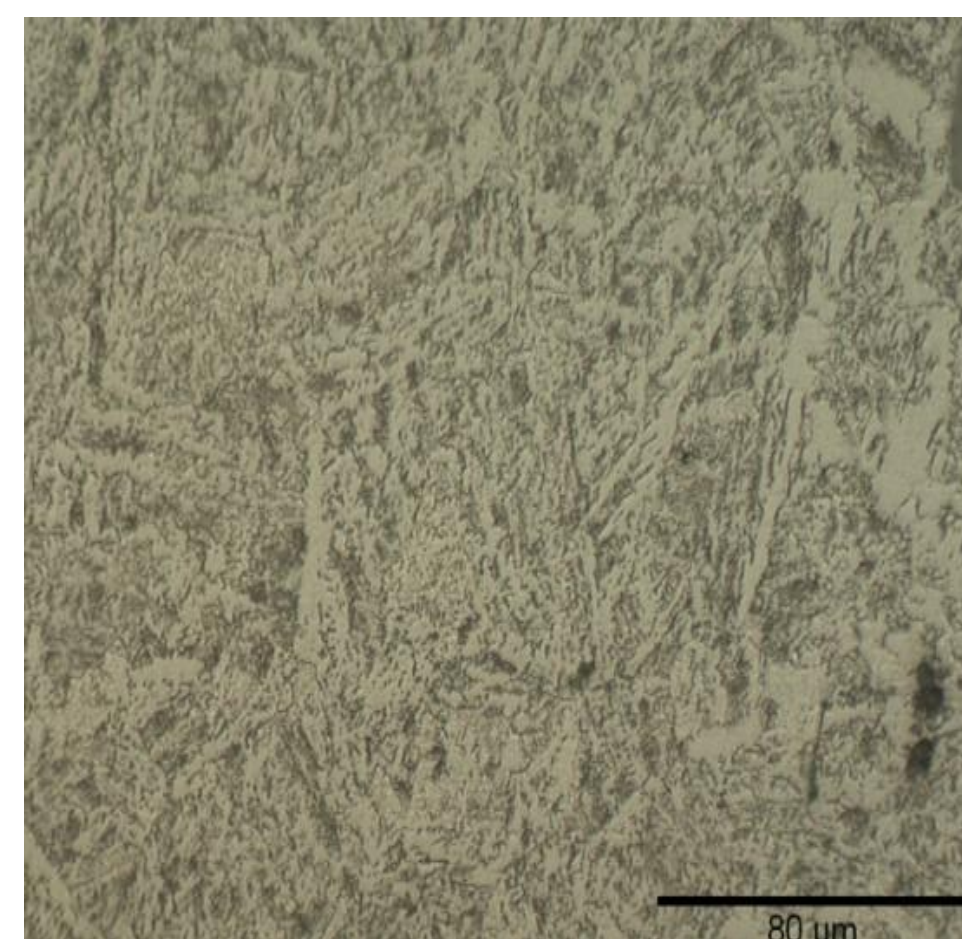


Figure 3: Micrograph of Plate A-2. 500 X.

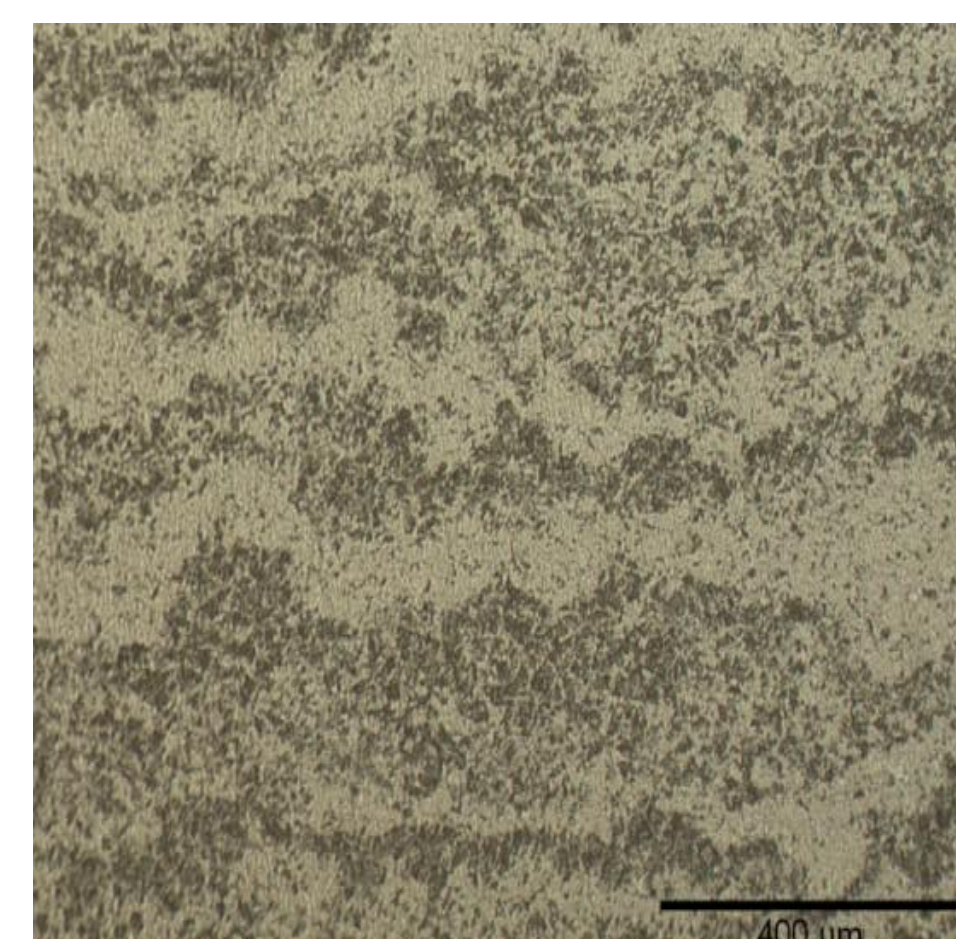


Figure 4: Micrograph of Plate A-3. 100 X.

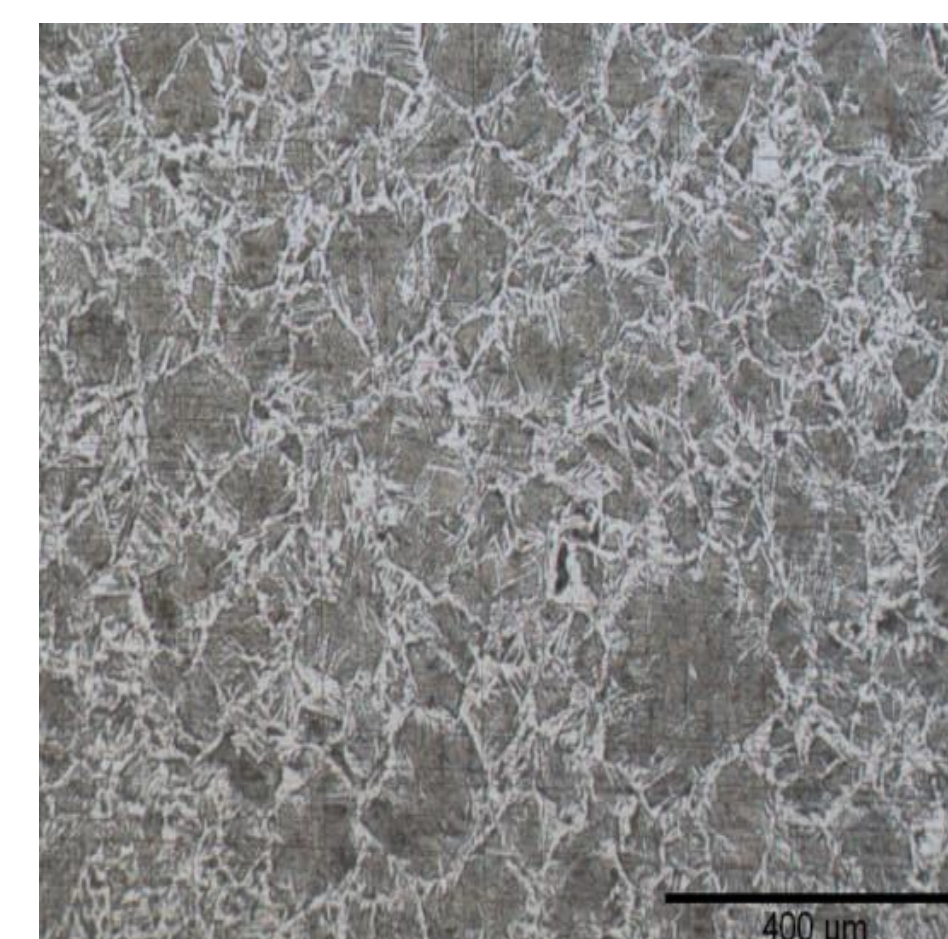


Figure 5: Micrograph of the Rivet. 200 X.

- 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 corrosion-susceptibility given the same conditions.
- 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**.



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

Table 1: Results of the carbon content analysis.

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

Corrosion Rate Analysis

- Corrosion rate data was obtained using PAP (potentiodynamic anodic polarization) 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.

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

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



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.

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