From: Commanding Officer, Naval Air Engineering Center, Phila., Pa. 19112  
To: Commander, Naval Air Systems Command (AIR 520331)  


Ref: (a) Private communication with H. W. Gilbert STIC, U. S. Navy, of 11 July 1966  

Encl: (1) Plate 1 - Physical Appearance of Sample  

1. Under the authorization of the subject assignment, a sample of material, apparently metallic, was submitted by Dr. H. W. Gilbert of the Scientific and Technical Intelligence Center, U. S. Navy for identification and possible clues regarding its origin. In addition to the verbal report of the results obtained, it was subsequently requested by reference (a) that a written report be submitted.  

2. The physical appearance of the sample as received was similar to a metallic sulfide matte and had a brass-like color. Plate 1 is a photomicrograph of a cross-section of the material in which stratifications are clearly defined. Alternate layers appear to be more metallic than the others.  

3. The sample was further tested as follows:  
   
   (a) The specific gravity of the sample was determined and was found to be 4.76.  
   
   (b) The metallic composition was determined spectrographically to be:  
      
      Major elements - Nickel, Cobalt  
      
      Trace elements - Iron, Manganese, Chromium, Silicon, Aluminum, Copper, Zinc  
      
      The density of the spectrographic lines indicated the nickel to cobalt ratio to be in the order of three to one.
Qualitative chemical analysis established sulfide as the major anion.

Electron diffraction studies were made in an attempt to establish the origin of the material. Although the impurities present offered some interference to the electron diffraction patterns, evidence for presence of the following was obtained:

<table>
<thead>
<tr>
<th>Likelihood of Presence</th>
<th>Compound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very good</td>
<td>NiS (Millerite)</td>
</tr>
<tr>
<td>Very good</td>
<td>NiS (Bunsenite)</td>
</tr>
<tr>
<td>Good</td>
<td>CoS$_2$ (Cattierite)</td>
</tr>
<tr>
<td>Good</td>
<td>CoNiO$_2$ (Cobalt-Nickel-Oxide)</td>
</tr>
<tr>
<td>Good</td>
<td>NiCO$_3$ (Nickel Carbonate)</td>
</tr>
</tbody>
</table>

Based on the spectrographic analysis, the electron diffraction studies, and the comparison of the specific gravity with that of materials reported in the literature, it is considered that the sample probably originated from a refining or smelting process for cobalt and nickel.

This is a partial report under the subject assignment which is being held open for additional investigations of a similar nature.

F. S. WILLIAMS
By direction
PHYSICAL APPEARANCE OF SAMPLE

PHOTO NO: CAN-376725(L)-7-66

PLATE 1
A sample of material, submitted by Dr. H. W. Gilbert of the Scientific and Technical Intelligence Center, U. S. Navy, was examined for identification and possible clues regarding its origin.

Based on the spectrographic analysis, the electron diffraction studies, and the comparison of the specific gravity with that of materials reported in the literature, it is considered that the sample probably originated from a refining or smelting process for cobalt and nickel.
### Security Classification

**14. KEY WORDS**

| METALLIC SULFIDE |

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