

EXAMINATION OF SIX TALC SAMPLES FROM DUNCAN ENTERPRISES

by

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Examination of Six Talcs From  
Duncan Enterprises

The six talc samples <sup>1/</sup> submitted by Congressman John Krebs on behalf of his constituent Mr. Tom Hinds, Vice President of Duncan Enterprises, Fresno, California, were examined by the Particulate Mineralogy Unit (PMU), Bureau of Mines. No conclusion should be derived from this report that these specimens are either representative of the respective deposits or, for the Nytal sample, the talc ore or processing procedures. The six specimens were augmented by a Bureau-collected ore sample to allow for a more complete characterization.

There are two hydrated groups of silicate minerals that have asbestiform varieties: the fine fibrous form of serpentine group known as chrysotile and the four fibrous forms of the amphibole group--anthophyllite asbestos, cummingtonite-grunerite asbestos, tremolite-actinolite asbestos, and crocidolite. Generally, the occupational regulatory agencies ignore the fact that the amphibole-group minerals can crystallize in either an asbestiform or a nonasbestiform habit and call all particles of these minerals "asbestos." This identification is based solely on an equal to or greater than three-to-one (3/1) length-to-width (l/w) ratio, longer than five micrometers, as determined by the membrane filter method at 450X using phase contrast illumination.

The five rock specimens were examined macroscopically prior to crushing. Thin sections of these specimens and the Bureau-furnished sample were prepared and examined under the light optical petrographic microscope, a conventional mineralogist's tool, to determine gross rock mineralogy and other physical characteristics. The site specific nature of asbestos determinations require this approach. Finely divided representative portions of the specimens were also examined under the petrographic microscope, X-ray diffractometer (XRD), and scanning (SEM) and transmission electron microscopes (TEM). The X-ray diffractometer, is a powerful screening tool which permits not only the detection of minor amounts of the asbestiform silicate mineral groups but can also indicate whether additional confirmatory microscopy is required. The absence of these group minerals in the X-ray data would preclude any further work. Intricate and sophisticated techniques are essential in determining conclusively whether or not any of the five asbestos minerals are present because, as noted above, they all have nonasbestos counterparts. A combination of light optical microscopy, SEM and TEM, are required to prove conclusively whether or not a mineral is asbestos.

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<sup>1/</sup> Commercial talcs can be variable mixtures of minerals in which the hydrated silicate mineral talc may be a minor constituent. Other minerals commonly present in talcs are chlorite, tremolite, carbonates (e.g. dolomite and calcite) quartz, anthophyllite, and the serpentines (e.g. antigorite-lizardite and chrysotile.)

The six samples examined are identified as:

Sample 1	Apex
2	Mongolian
3	Bonny
4	Eclipse
5	Acme
6	Nytal 100HR

Examination of the six samples are summarized as follows:

- A. Samples No. 1, 2, and 6 have major amounts of nonasbestos tremolite and talc. A few bundles of asbestiform tremolite were detected in sample No. 6.<sup>2/</sup>
- B. Samples No. 3 and 4 are essentially talc with minor amounts of carbonates.
- C. Sample No. 5 is principally nonasbestos tremolite with a small amount of talc.

Specific comments together with macro- and microphotographs along with X-ray diffractometer data traces are provided on each of the six samples. Electron microscopic data, not illustrated, failed to detect the presence of the asbestiform serpentine mineral, chrysotile, in any of the crushed samples.

Sample 1. The hand specimen is classified as a soapstone due to its unoriented structure (see figures 1 and 23) and high talc content (see figures 3 and 29.) Examination of a ground portion of the specimen shows that the major minerals are talc and tremolite (figure 2). The smaller particle size ranges consist mainly of nonasbestiform tremolite cleavage fragments (figure 4) which is characteristic of sample preparation. The specimen also contains a minor amount of calcite and serpentine (figure 29.) The serpentine group mineral is the nonasbestiform, antigorite-lizardite.

Sample 2. This specimen is also classified as a soapstone (figure 5.) The major minerals present are talc and tremolite (figures 6, 24 and 30) with a trace amount of mica. The tremolite, again the nonasbestos variety, includes numerous cleavage fragments as shown in figure 7.

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<sup>2/</sup>

The terms "asbestos and asbestiform" are synonymous and apply only to the fibrous forms of these minerals as they crystallize in nature. It should also be noted that the Nytaal samples was received in powdered form whereas the other samples were crushed at the PMU.

Sample 3. Due to the foliated structure (figure 8) and high talc composition (figure 25) the hand specimen is classified as a talc schist. After grinding, most of the particles were identified as talc plates (figures 9 and 10), with minor amounts of calcite (figure 31) and trace amounts of quartz. Neither forms of tremolite were observed.

Sample 4. This hand specimen shows unoriented structure, has a very high talc content, (figure 26) and is a soapstone (figure 11). There is a minor amount of dolomite (figure 32). The sample is composed principally of irregular talc plates (figures 12 and 13).

Sample 5. This rock specimen, composed primarily of nonasbestiform tremolite with a small amount of talc, (figures 27 and 33), displays slight foliation and is deemed a tremolite schist (figure 14). Because of characteristic amphibole cleavage many tremolite particles break into small needle-like grains during sample preparation (figures 15 and 16).

Sample 6. This sample was received as a fine powder. In order to permit equal treatment of all samples, a Bureau-provided hand specimen collected from the Nytal talc operation was provided. This rock (figures 17 and 28) is representative of one of the ores presently being mined and is defined as being massive and granular. The major constituents in the powdered material are nonasbestos tremolite and talc, (figure 34). Antigorite-lizardite, the nonasbestiform serpentine mineral, and calcite are minor constituents with traces of mica. The particles vary over a wide range of shapes and sizes, from blocky nonasbestos tremolite to irregular plates of talc, (figure 18). Most of the tremolite particles are cleavage fragments of nonasbestiform tremolite (figures 19 and 21), but a few were detected which are asbestiform (figures 20 and 22).



FIGURE 1. Photomacrograph of hand sample of talc (sample 1) exhibiting unoriented texture.

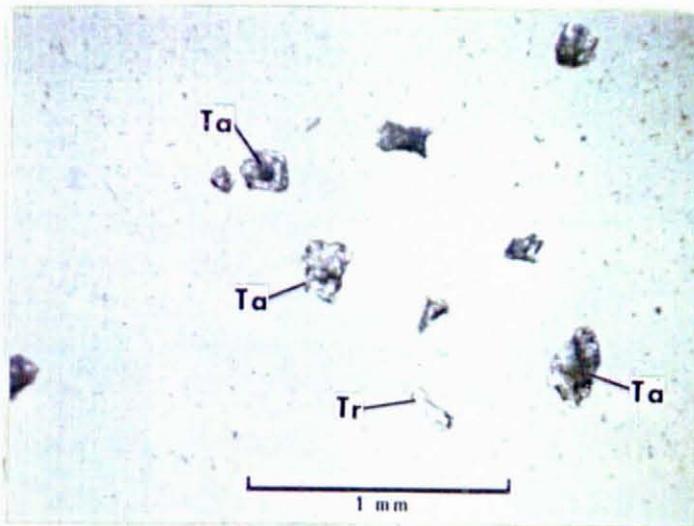


FIGURE 2. Photomicrograph of ground sample 1 showing platy talc (Ta) and cleavage fragments of tremolite (Tr).

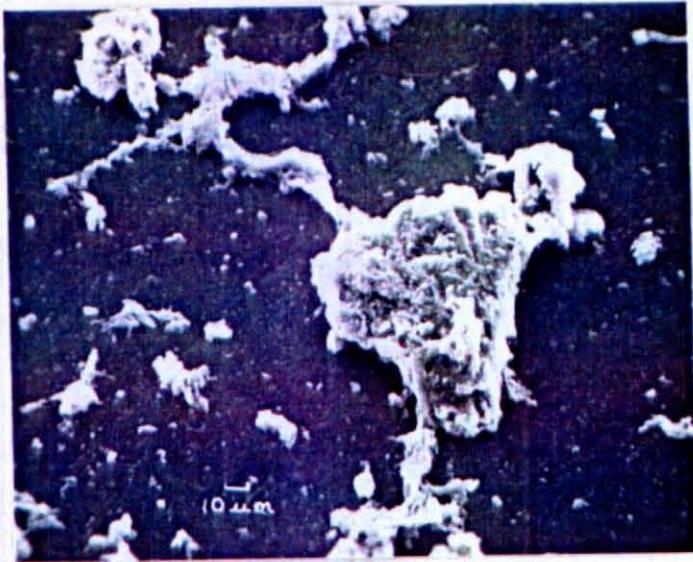


FIGURE 3. Scanning electron micrograph showing platy talc.

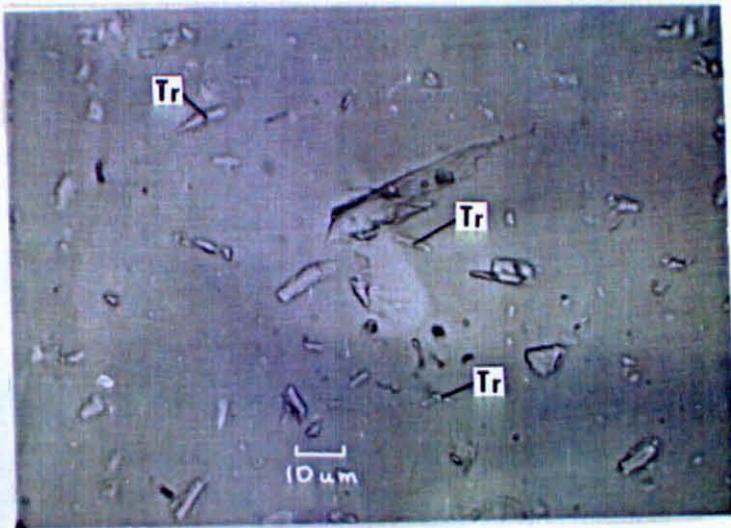


FIGURE 4. Photomicrograph of acicular tremolite cleavage fragments (Tr) in the finer size fraction of sample 1.



FIGURE 5. Photomicrograph of sample 2. This material is classified as a soapstone.



FIGURE 6. Agglomerates of fine-grained platy talc and some tremolite particles.

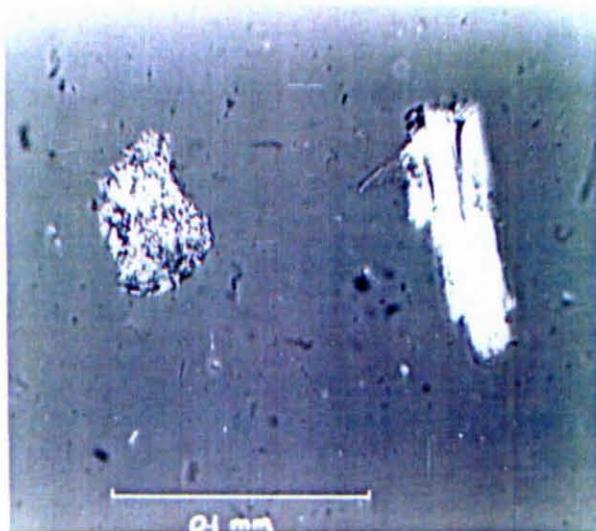


FIGURE 7. Enlargement of a portion of Fig. 6 showing an agglomerate of talc plates (left) and a cleavage grain of tremolite (right).

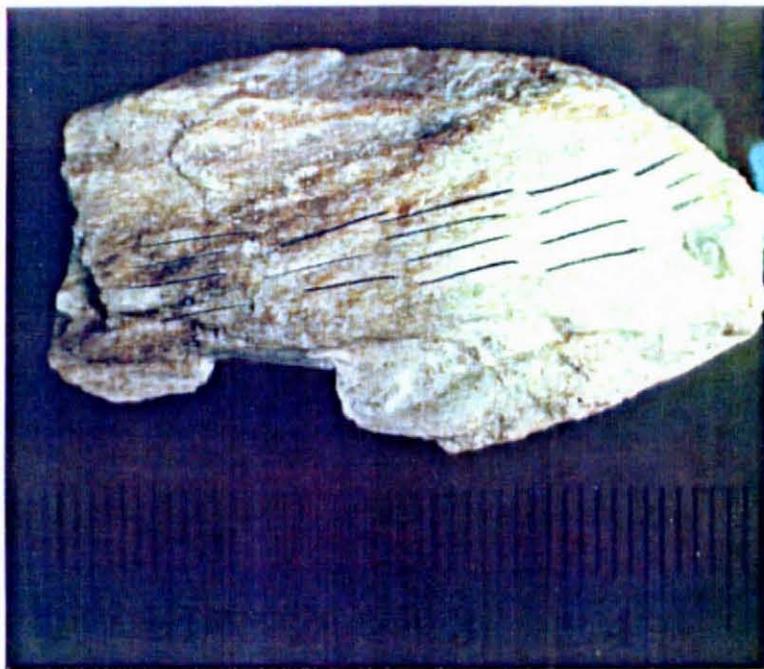


FIGURE 8. Sample 3 displays the typical foliated structure of a talc schist as shown in this photomacrograph.

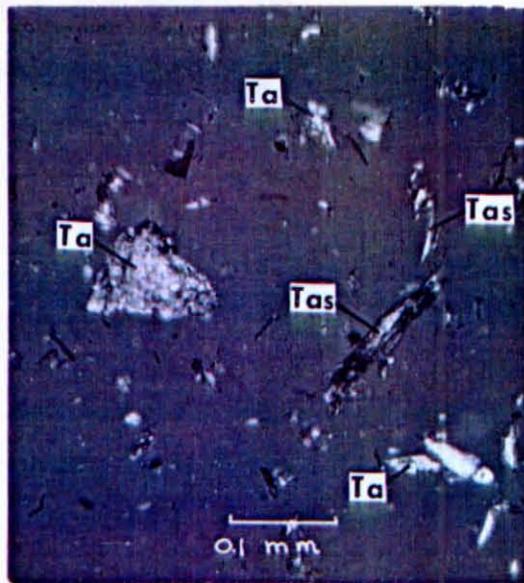


FIGURE 9.

Plates of talc (Ta) are visible in this photomicrograph. Some particles which appear acicular are actually side views of plates of talc (Tas).

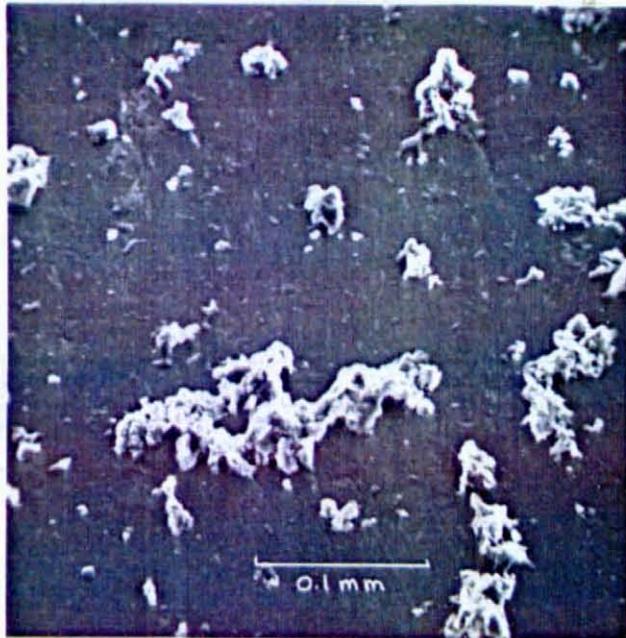


FIGURE 10.

Scanning electron micrograph of agglomerates of talc plates.



FIGURE 11. Photomacrograph of sample 4 exhibiting typical unoriented structure of soapstone.

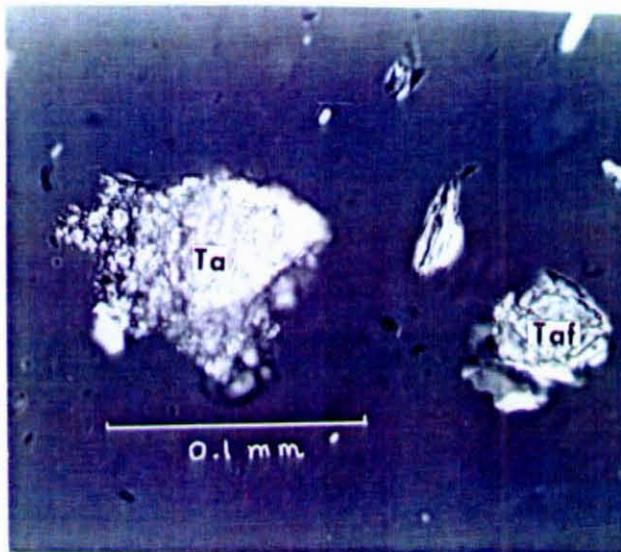


FIGURE 12. Photomicrograph showing irregular plates of talc. One particle is an agglomerate (Ta) while another appears as a single flake (Taf).

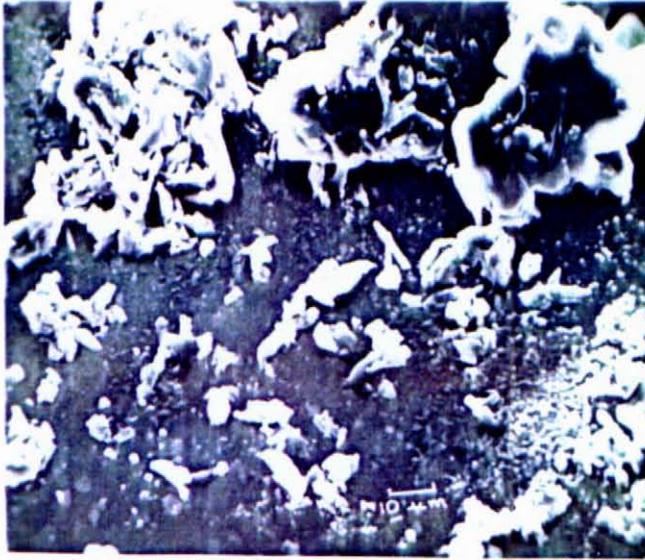


FIGURE 13. Scanning electron micrograph showing talc's typical platy morphology.

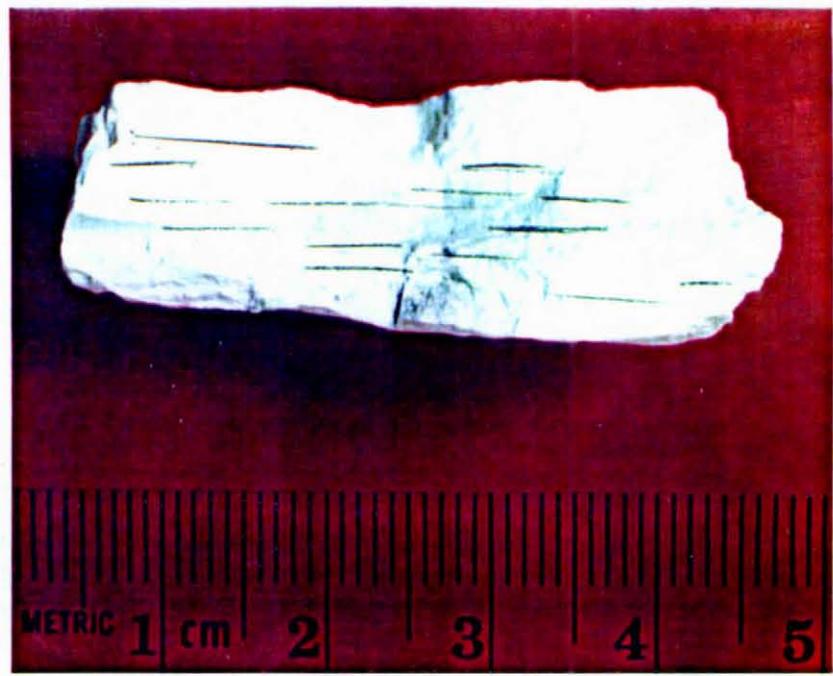


FIGURE 14. Photomicrograph of sample 5 showing slightly foliated tremolite schist.

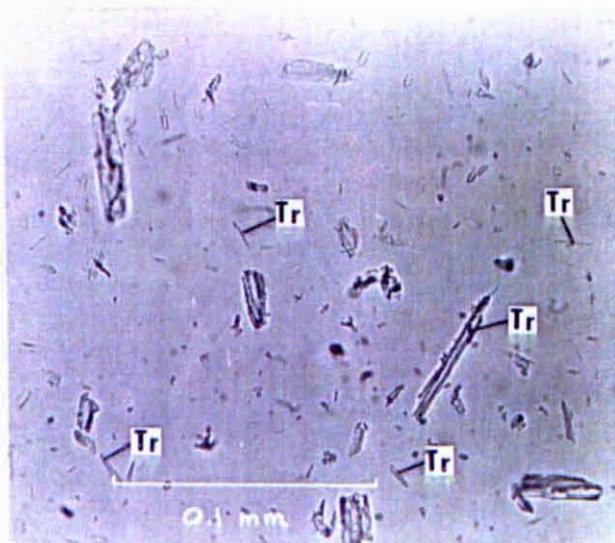


FIGURE 15. Photomicrograph of tremolite cleavage fragments, many of which are acicular (Tr).



FIGURE 16. Scanning electron micrograph illustrating the various tremolite cleavage fragments.



FIGURE 17. Photomacrograph of Bureau provided Nyal talc ore showing massive unoriented granular texture.

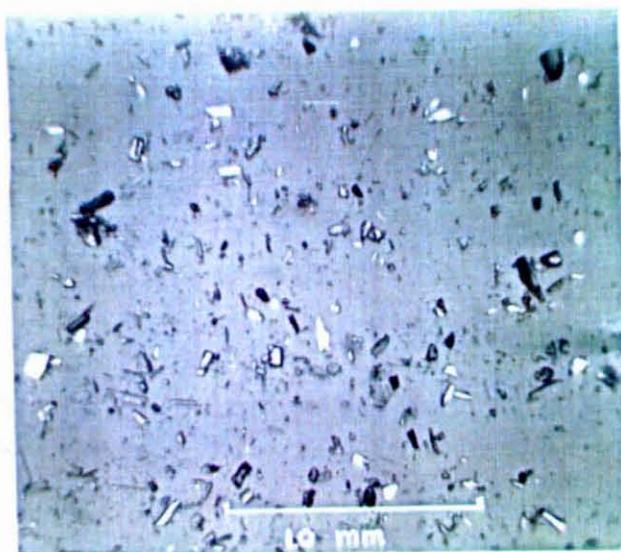


FIGURE 18. Photomicrograph of sample 6 showing the variety of particle sizes and shapes characteristic of this material.

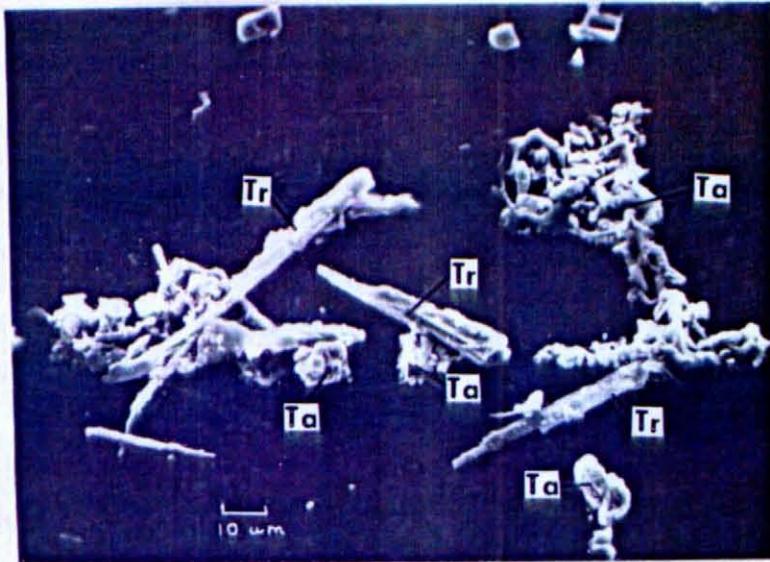


FIGURE 19.

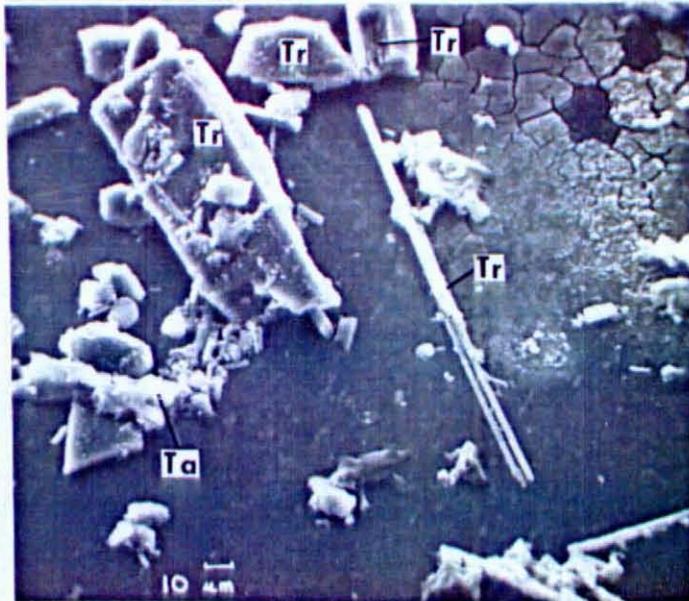


FIGURE 20.

FIGURES 19 and 20. Scanning electron micrographs showing blocky tremolite cleavage fragments (Tr), irregular plates of talc (Ta), and in Fig. 20, in the right-center of the photograph, a fibrous tremolite particle.



FIGURE 21. Photomicrograph of tremolite particles displaying amphibole cleavage (Tr).

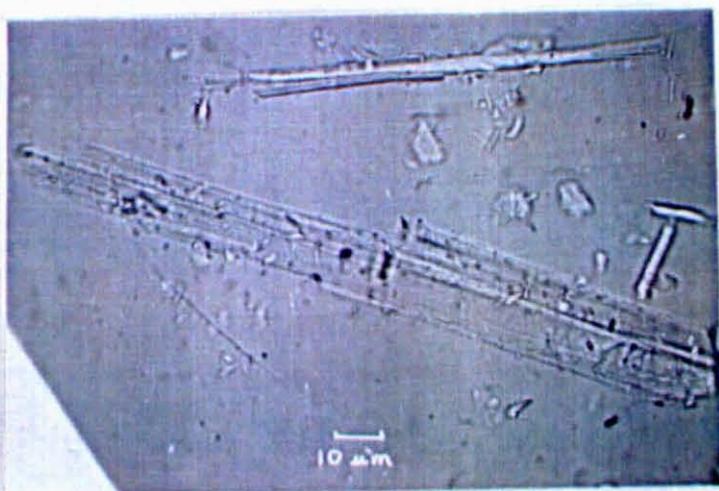
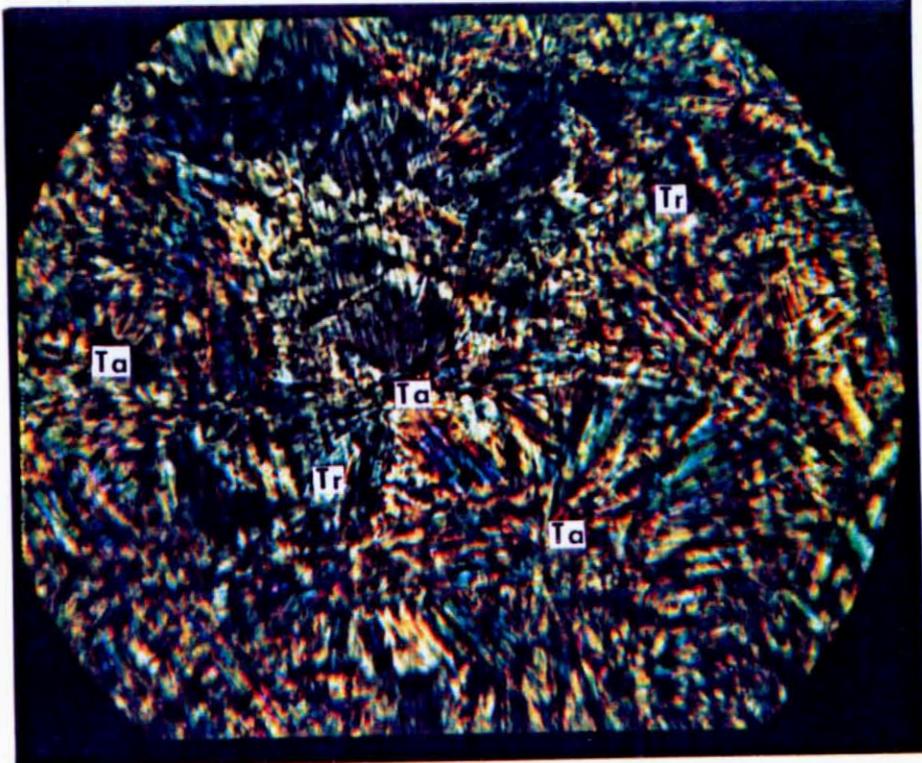
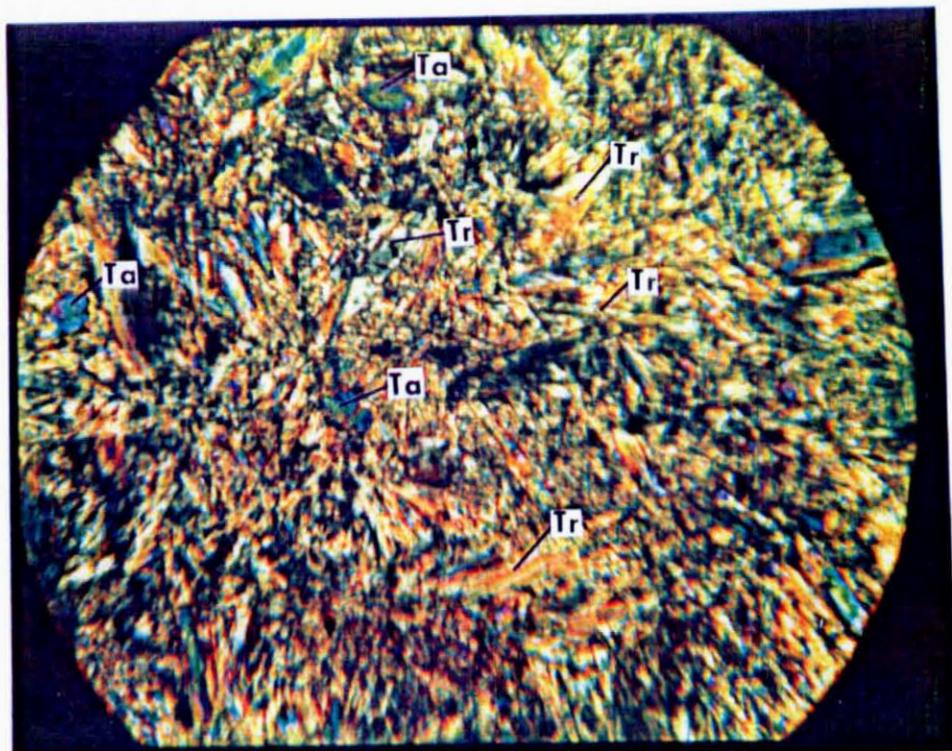


FIGURE 22. Photomicrograph showing a tremolite fiber (top) and elongated tremolite cleavage fragments.



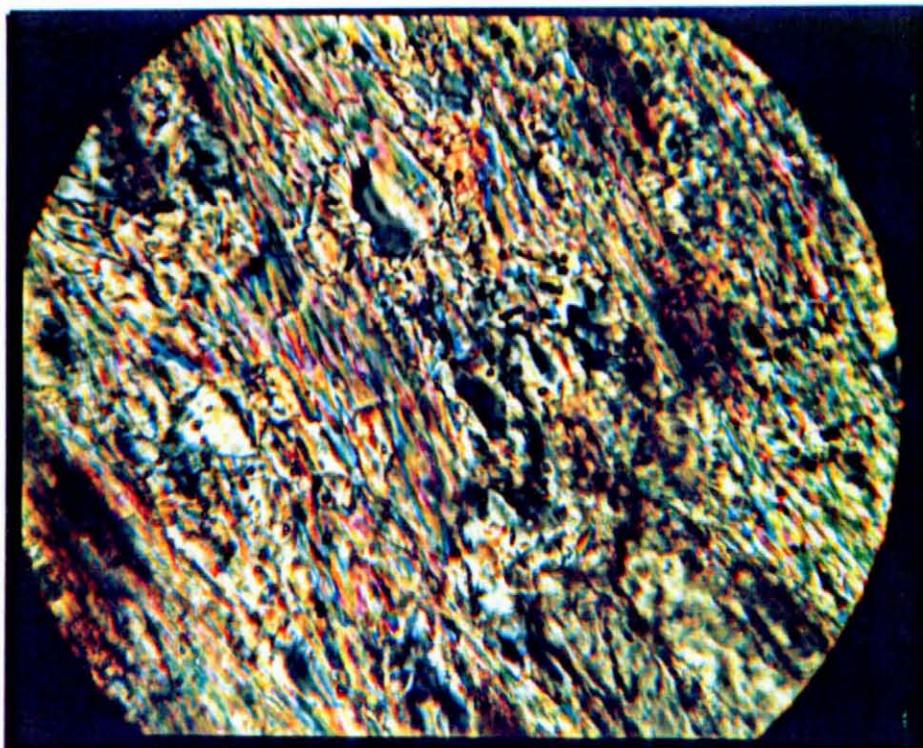
X 140

FIGURE 23. Photomicrograph of thin section of sample 1 showing radiating plates of talc (Ta) with some unoriented grains of tremolite (Tr).



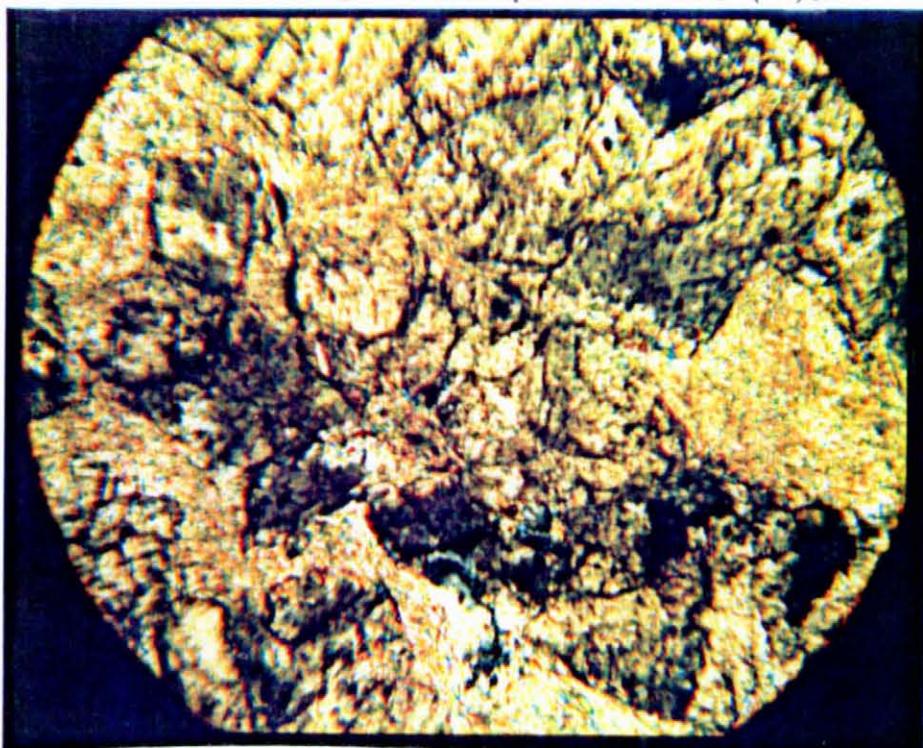
X 140

FIGURE 24. Photomicrograph of thin section of sample 2 showing lath-like grains of tremolite (Tr) surrounded by fine-grained talc (Ta).



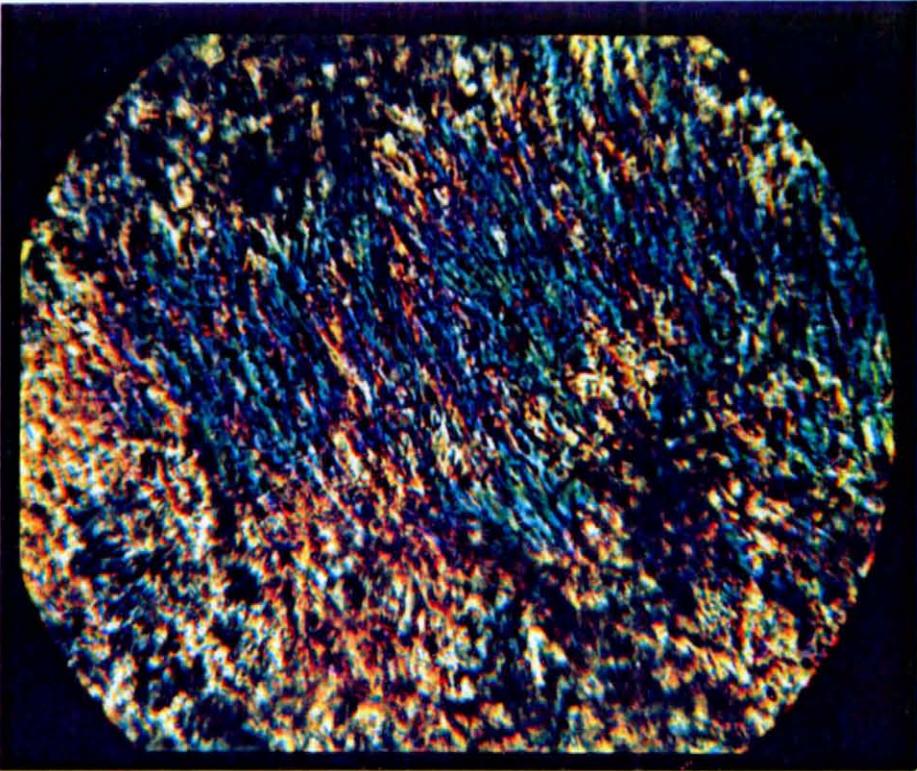
X 350

FIGURE 25. Photomicrograph of thin section of sample 3 showing oriented plates of talc (Ta).



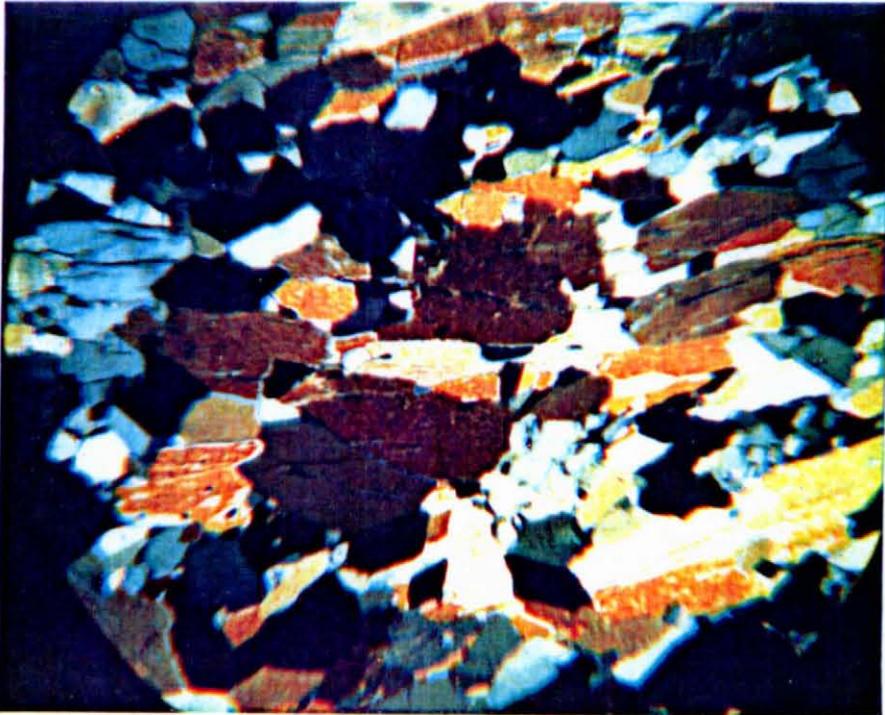
X 140

FIGURE 26. Photomicrograph of thin section of sample 4 showing essentially unoriented plates of talc (Ta).



X 350

FIGURE 27. Photomicrograph of thin sections of sample 5 showing oriented needle-like tremolite (Tr).



X 35

FIGURE 28. Photomicrograph of thin section of Nyal talc ore showing unoriented subhedral grains of tremolite.

### X-Ray Diffraction

Figures 29 to 34 are X-ray diffractometer scans over the range 5 to 50° 2 $\theta$  for the six samples. These scans were made using a Philips Electronics wide angle diffractometer with an AMR focusing monochromator at a scanning speed of 1° 2 $\theta$  per minute and Copper K $\alpha$  radiation. The data are summarized as follows:

- Sample
1. Talc, tremolite, calcite, serpentine
  2. Talc, tremolite
  3. Talc, calcite
  4. Talc, dolomite
  5. Tremolite
  6. Talc, tremolite, serpentine, calcite

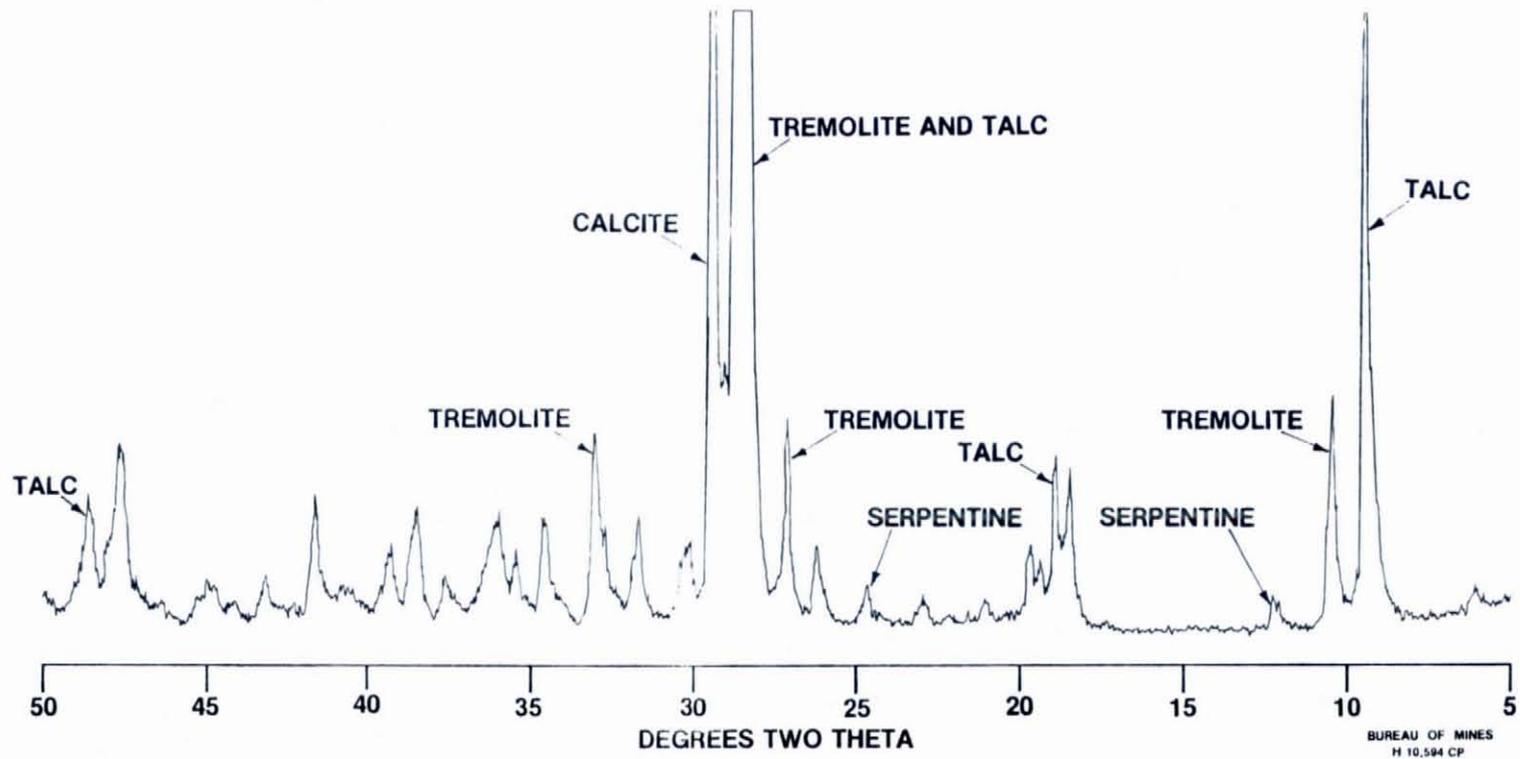


FIGURE 29. X-Ray diffractometer scan of sample 1.

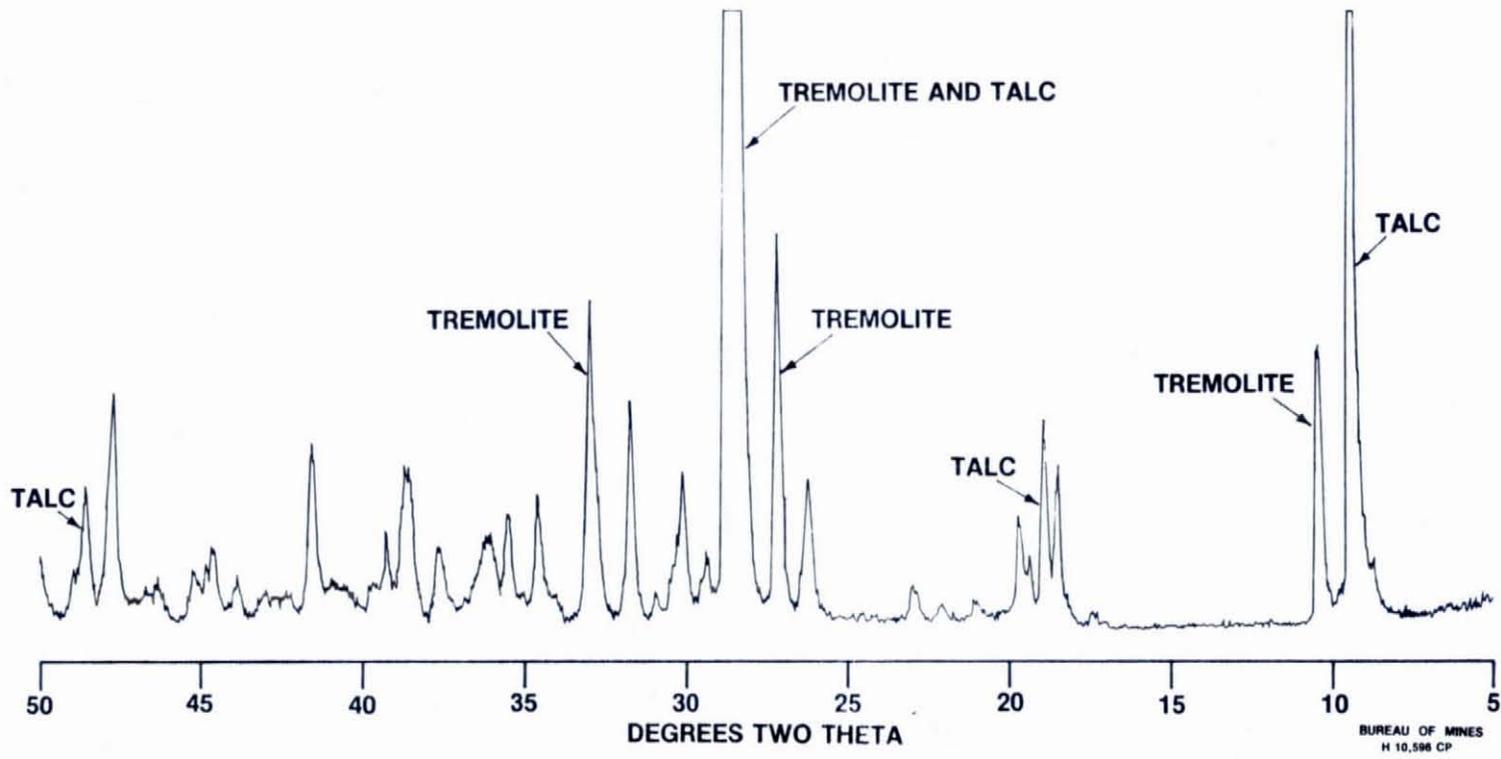


FIGURE 30. X-Ray diffractometer scan of sample 2.

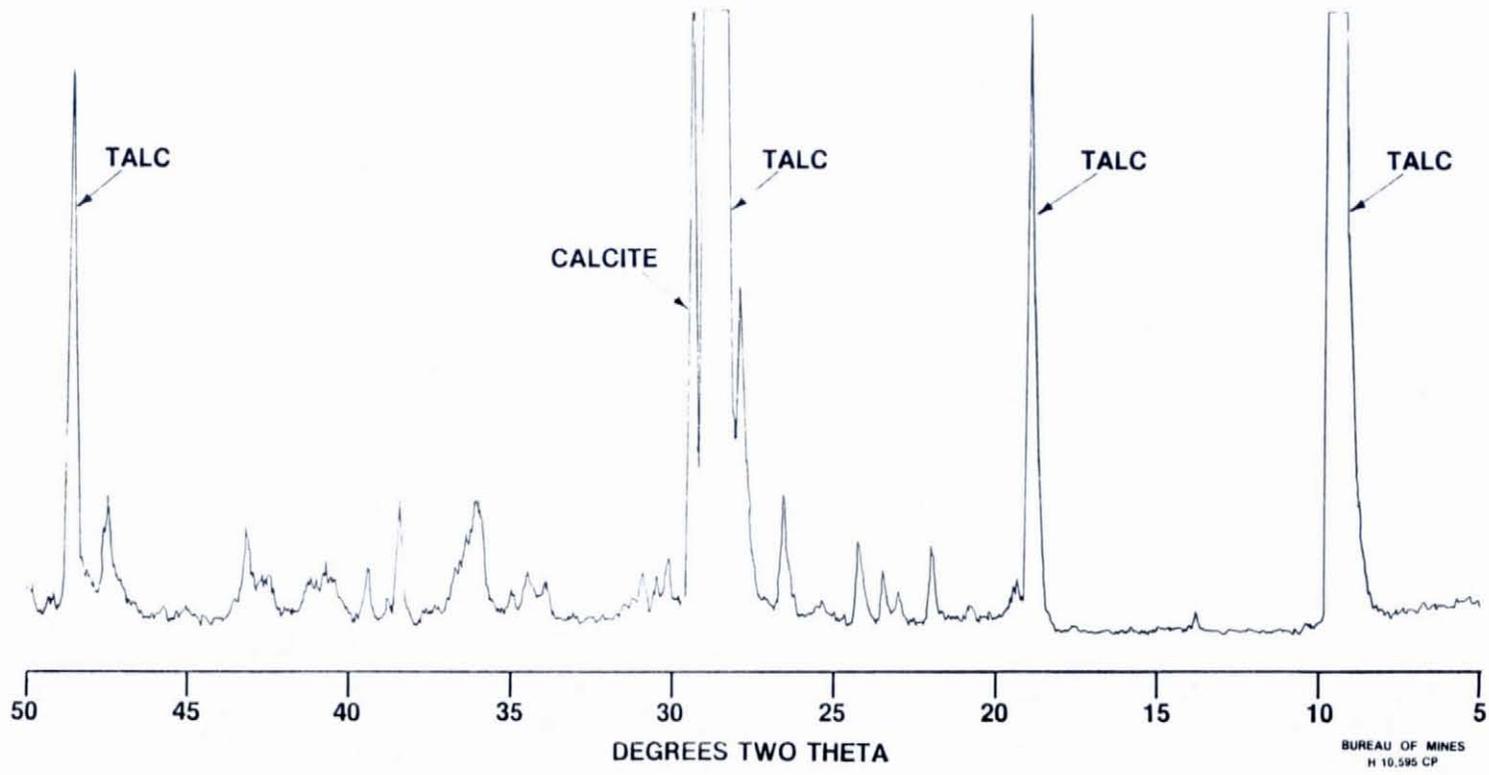


FIGURE 31. X-Ray diffractometer scan of sample 3.

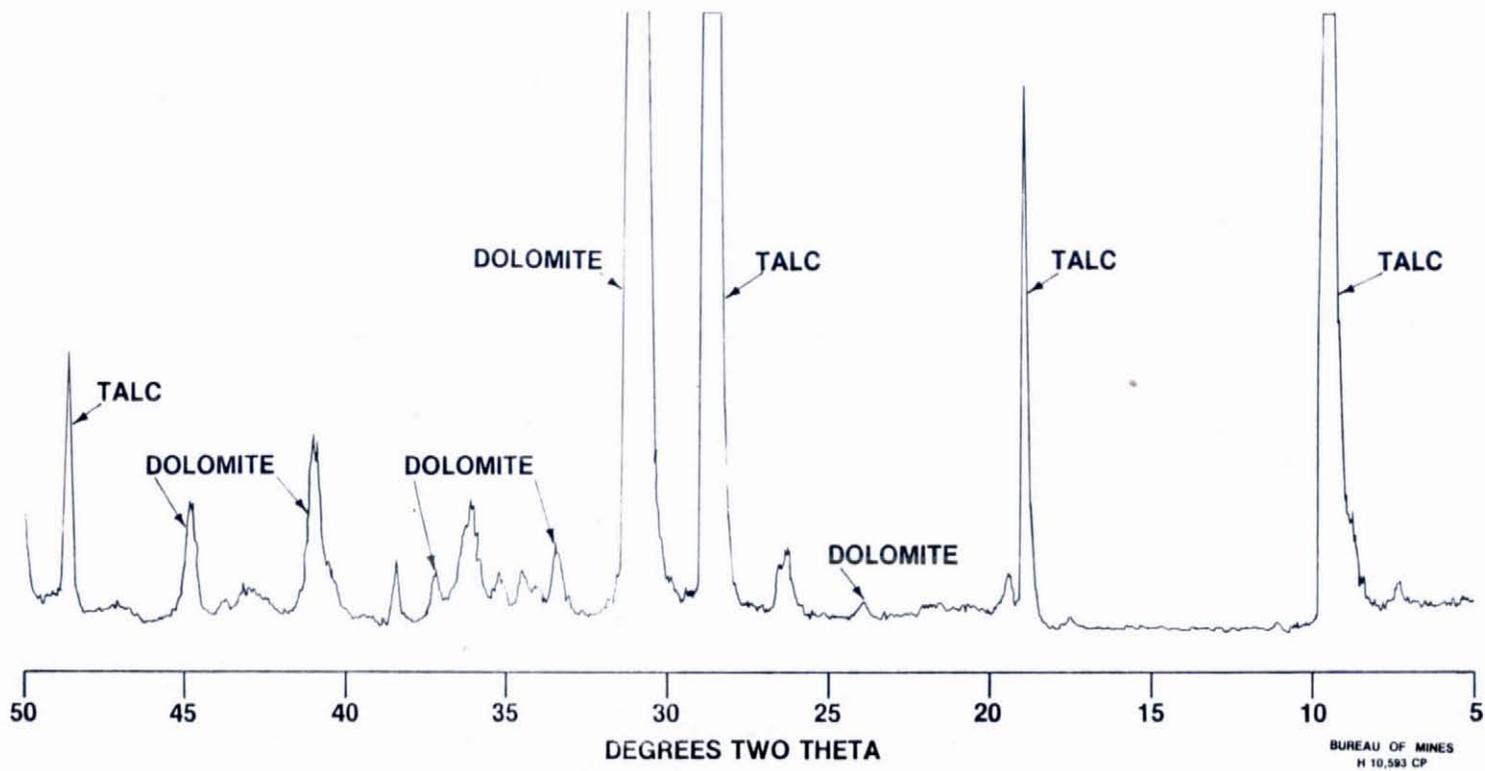


FIGURE 32. X-Ray diffractometer scan of sample 4.

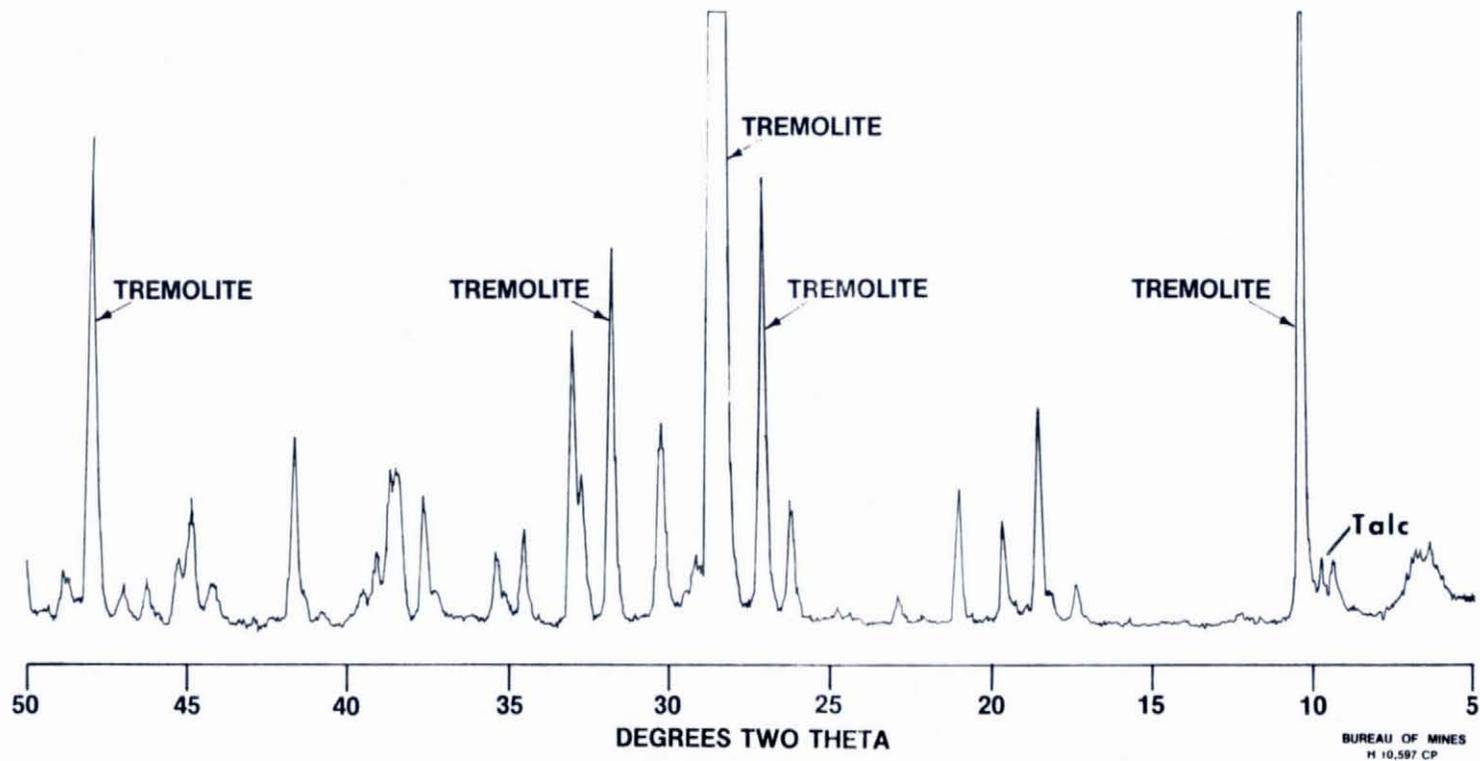


FIGURE 33. X-Ray diffractometer scan of sample 5.

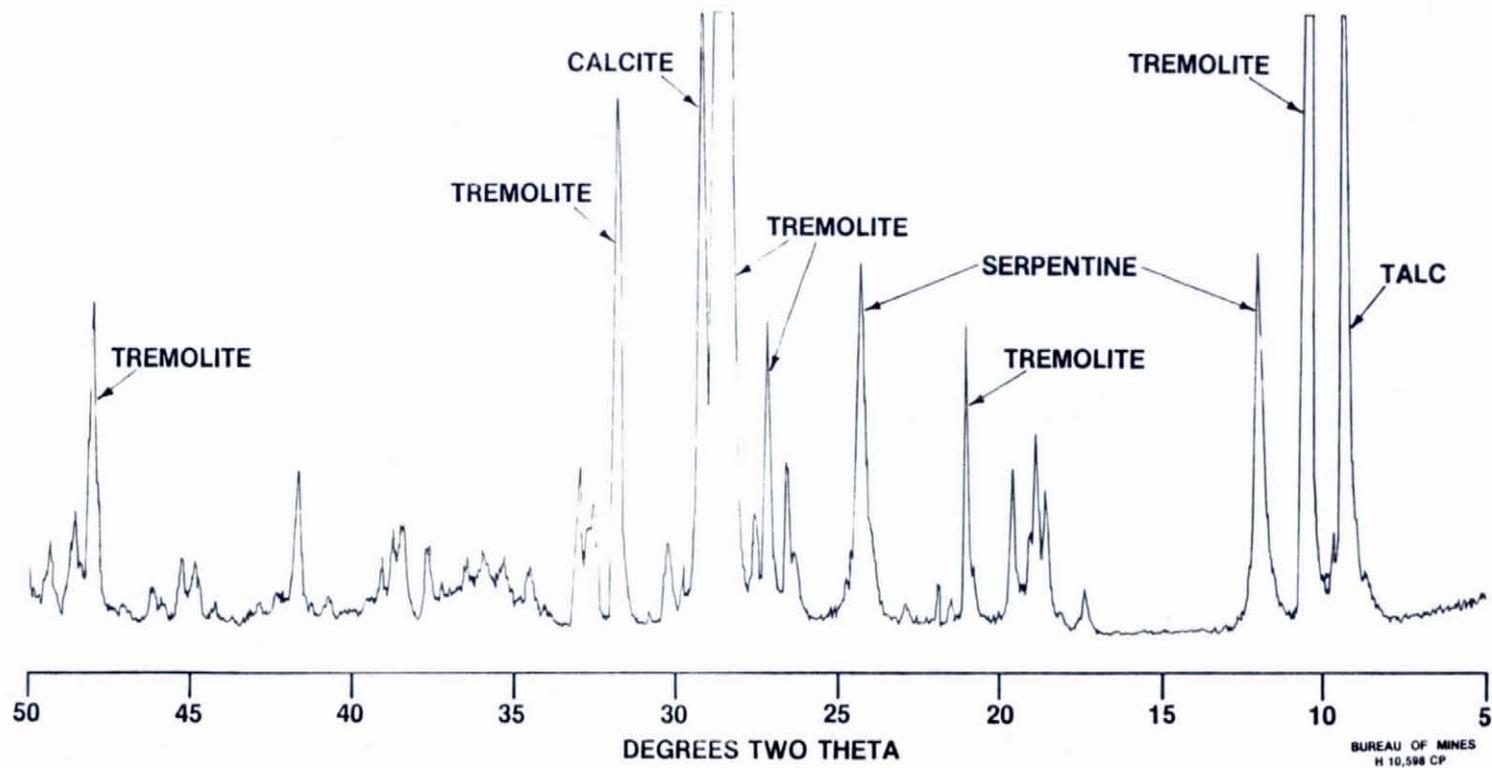


FIGURE 34. X-Ray diffractometer scan of sample 6.