

# Mineralogy and major element chemistry of suspended sediments from the Chilean archipelago: R/V *Hero* cruise 76-4

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From 20 June to 6 July 1976, samples of suspended and bottom sediments were collected from the R/V *Hero* at 40

stations in the network of fjords along the southern coast of Chile (Siegel *et al.*, 1976 a). The work was an extension of a study initiated the previous summer on the southern Argentine continental shelf (Siegel *et al.*, 1976 b) in an effort to characterize the geochemistry and mineralogy of sediments being deposited on either side of the Patagonian peninsula. The region provides the rare opportunity to study sediments deriving from similar source areas but traversing radically different environments during transport and deposition. Further, the location of the Chilean study area relative to the South American porphyry copper belt favors the existence of metallogenic zones within regions that contribute sediment to offshore areas. The situation may well provide a chance to test the utility of recent sediments as a prospecting tool in coastal waters (Siegel *et al.*, 1976 c).

The analysis of the mineralogy and major element chemistry of suspended sediment samples is essentially complete. Work continues on the trace element chemistry of suspensates as well as on the mineralogy, and major trace element chemistry of bottom sediments. This paper outlines the results to date.

*Methodology.* Sample collection techniques and the procedure for X-ray diffraction analysis were described in an earlier paper (Siegel *et al.*, 1976 a). Six major elements (silicon, aluminum, iron, magnesium, calcium, and potassium) were analysed in the suspended sediments by thin-film X-ray fluorescence spectrometry, using a modified version of the technique described by Baker and Piper (1976). A small quantity (1 milligram or less) of suspended sediment was collected on the surface of a 0.45-micron pore size, 47-millimeter diameter Millipore HA filter by vacuum filtration of seawater. After a washing step with 500 milliliter of distilled water, the filters were mounted on plexiglas ring supports with a cement of collodion and amyl acetate. The rings serve to support the filters and prevent curling of the filter surfaces during analysis. Because the parts of the filters supported by the rings were masked from the X-ray beam, background interference from the rings and mounting cement was avoided. Calibration curves were prepared using ground U.S. Geological Survey standard rocks. Due to limitations of the analytical technique, sodium, titanium, phosphorus, manganese, and sulfur were not analyzed. Results were expressed as the oxide and were weight-normalized to 100 percent. As the elements reported normally comprise 95 percent or more of the mineral fraction of the samples, it was felt that this technique would not be subject to large errors and would adequately reflect major trends.

Preliminary estimates of mineralogical variation from sample to sample were made by measuring the height above background of the major reflection of each mineral on the

X-ray diffractogram, summing the peak heights, and calculating a "relative percent contribution to total diffracted intensity" for each mineral. Although this method cannot yield quantitative results because of variations in the mass absorption characteristics of different mineral species, it should adequately represent mineralogical trends among samples.

*Mineralogy results.* The mineral suite in the suspended sediments is dominated by chlorite and illite accompanied by subequal quartz, feldspar, talc and amphibole (Siegel *et al.*, 1977). Talc is occasionally the dominant mineral phase. Other minerals irregularly present include magnesian calcite, dolomite, gypsum, and mixed layer clay. Areal variations in mineralogy reflect the influence of large as well as small scale geologic features. Sediments deriving from predominantly metamorphic terrain tend to be enriched in chlorite, while suspensates from waters draining mostly igneous source areas generally contain less of this mineral and more illite.

Discrete zones of higher concentrations of feldspar and amphibole are apparent, this probably being due to small scale mineralogic variations in major rock units. Unusually high concentrations of talc in isolated areas may indicate local hydrothermal alteration of basic rocks. Mineralogy varies relatively little in vertical profile, with the exception of deep (greater than about 140 meters) stations, where bottom water suspensates often exhibit marked mineralogical differences from those in surface waters. This most likely reflects the influx of colder and denser glacial discharge waters which originated in a geologically dissimilar source area.

*Chemistry results.* The averages, standard deviations and ranges of the six major elements determined in suspensates are given in the table. An initial comparison of chemical and mineralogical data suggests a general relationship of chlorite with magnesium, illite with aluminum and potassium, amphibole with iron, and feldspar with aluminum and calcium. There was no apparent relationship of amphibole and talc with magnesium. A satisfactory explanation of these discrepancies is not immediately available. Two possibilities being examined are (1) error in X-ray fluorescence analysis due to particle size effects and (2) sample segregation caused by settling of coarse particles during processing. A more detailed analysis of the mineralogy and chemistry of anomalous samples is also being done.

The effects of biogenic particulate matter on the chemistry of suspensates appear to be limited to variations in silica concentrations. Scanning electron microscope examination of samples that have higher than average levels of silicon reveal correspondingly greater quantities of siliceous diatoms.

Average values (in weight percent), standard deviations, and ranges of six elements determined in Chilean suspended sediments.

N = 59	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	MgO	FeO	CaO	K <sub>2</sub> O
$\bar{X}$	48.0	14.7	6.0	8.8	16.0	6.3
$\sigma$	7.7	5.5	3.4	1.9	11.4	3.6
Range	28.0-56.4	2.0-23.7	3.4-16.6	3.6-12.9	4.6-54.6	1.8-18.8

*Comparison with Argentine suspensates.* There are obvious mineralogical differences between the Chilean suspensates and a suite of samples collected off the Argentine coast at approximately the same latitudes (Siegel *et al.*, 1977). Chemical data were not available for comparison. Montmorillonite is generally the dominant mineral in nearshore Argentine suspended sediments, and kaolinite is ubiquitous, although in much smaller quantities (Pierce *et al.*, 1976). Both of these minerals are absent in the Chilean sediments. These observations appear to reflect the influence of multistage processes operating on the Argentine side of the Patagonian peninsula, as opposed to predominantly single stage physical weathering processes operating on the Chilean portion.

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