Variability in spectral signatures of terrestrial ignimbrites and implications for volcanology on Mars. P.W. Francis, Lunar and Planetary Institute, 3303 NASA Road 1, Houston, Texas 77058.

Landsat Thematic Mapper (TM) studies of 2.2 my old ignimbrites in a test area around the Cerro Galan caldera, N.W. Argentina, show that the ignimbrites exhibit a remarkable range of spectral characteristics dependant both on intrinsic properties (welding, iron oxidation) and extrinsic properties resulting from aeolian weathering processes, notably deflation of low density pumic and glass and surface concentration of dense minerals and lithic clasts.
The TM has a spatial resolution of 30 m and is equipped with sensors working in seven spectral bands:

Band 1	0.45 - 0.52	micrometers
Band 2	0.53 - 0.61	"
Band 3	0.62 - 0.69	"
Band 4	0.78 - 0.91	"
Band 5	1.57 - 1.78	"
Band 6	10.42 -11.66	"
Band 7	2.08 - 2.35	"

The Cerro Galan caldera is an elliptical structure 35 km x 20 km. Ignimbrites erupted from the caldera totalling 1.2 km in thickness form the 6000m high resurgent center, while ignimbrites of the outflow facies are generally less than 100m thick but are exposed over 2-3,000 km^2 and extend radially to distances over 100 km from the caldera. Ignimbrites of the caldera facies are densely welded, while those of the outflow facies are lighlty welded or unwelded. Total volume of erupted ignimbrite exceeds 1000 km3. Chemically, it is a homogenous dacite (SiO_2 = 69%), composed of pumice clasts, shards, and phenocrysts of plagioclase, sanidine, quartz, biotite and magnetite.

Spectral profiles of the ignimbrite in four contrasted enviroments were constructed using 6 TM bands. (Fig.1) Fresh unwelded ignimbrite (A) has a high albedo with a marked spike in band 5, probably due to a surface film of oxidised iron minerals, goethite and hematite. Fresh welded ignimbrite (B) is much darker and resembles lava; it has only a very slight spike in Band 5; in places however, for reasons not fully understood, the welded ignimbrite is apparently highly oxidised, with a prominent spike in Band 5 (C). Most significant, however, is the contrast between fresh, unwelded ignimbrite (A) and the characteristic surface outcrop of such ignimbrites (D) over hundreds of square kilometres. The spectrum is very flat, resembling welded ignimbrite or lava.

Field studies show that such surfaces are lag gravels; covered by lithic clasts eroded out of the ignimbrite, all of the low density pumice and shards having been blown away. Heavy mineral concentrations are also locally important. Lithic clasts form only a small proportion by volume of the ignimbrite, of the order of 1%. In places, more than 30 m thickness of ignimbrite appears to have been blown away to leave the lag gravel concentrated on the surface. Thus, over most of its outcrop, the ignimbrite has a spectral signature which is unrelated to its bulk composition, but which is due to its least important component.

Spectral signatures of ignimbrites
P.W. Francis

The textural and structural characteristics of ignimbrites on Mars have been evaluated earlier (Francis and Wood 1982). Coupled with the conclusions made in the earlier study, the implications of the present observations are clear: it is impossible to identify unequivocally ignimbrites from remote sensed data, even in a well-studied terrestrial setting, without a detailed understanding of their environment. Although extremely extensive areas of ignimbrites have been mapped on Mars, e.g. in the Amazonis area (Scott and Tanaka, 1982) and the Olympus Mons aureole (Morris, 1982), only the most tenuous evidence to support their identification has been produced. For the most part, this relies on superficial morphological similarities between known terrestrial ignimbrites and postulated Martian examples. In the absence of young, well preserved source calderas or other vent structures unambiguously associated with them, suggestions of ignimbrites on Mars should be regarded as speculative. Little detailed spectral data is available at present for different units on Mars. When it does become available, it will have to be analysed cautiously. The lag gravels and heavy mineral concentrations observed at Cerro Galan also emphasize the need for care in interpreting the spectral characteristics of lithological units in areas where extensive aeolian erosion takes place.

References: Francis, P.W. and Wood, C.A., J. Geophys. Res., 87, 9881-9889,1982. Morris, E.C. J. Geophys. Res.; 87, 1164-1178, 1982. Scott, D.H. and Tanaka, K.L., J. Geophys. Res. 87, 1179-1190, 1982.

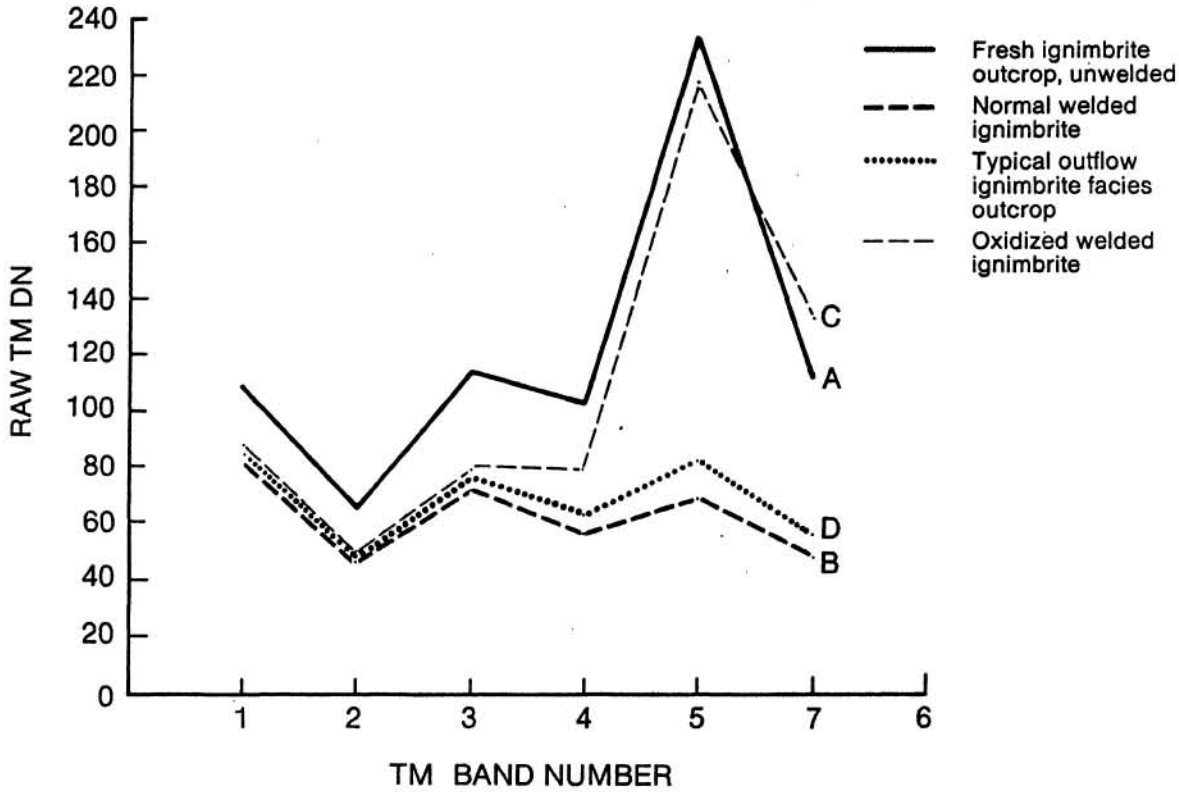

Figure 1