

MEASUREMENT OF ATMOSPHERIC WATER VAPOR, LEAF LIQUID WATER AND
REFLECTANCE WITH **AVIRIS** AT THE BOREAL ECOSYSTEM-ATMOSPHERE
STUDY: INITIAL RESULTS

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1. INTRODUCTION

The **Airborne Visible/Infrared Imaging Spectrometer (AVIRIS)** acquired data as part of the **Boreal Ecosystem-Atmosphere Study (BOREAS)** in 1994. Flights occurred over the Northern Study Area (**NSA**) in the region of 56 degrees north latitude and 98.5 degrees west longitude and over the Southern Study Area (**SSA**) 54 degrees north latitude and 105 degrees west longitude (**Table 1**).

Table 1. Acquisition of **AVIRIS** data for **BOREAS** in 1994.

Southern Study Area	19 April 1994
Northern Study Area	20 April 1994
Northern Study Area	28 April 1994
Northern Study Area	8 June 1994
Southern Study Area	21 July 1994
Northern Study Area	4 August 1994
Northern Study Area	8 August 1994
Southern Study Area	16 September 1994

These data will be used to directly derive spectral properties of the surface and atmosphere and to provide supporting data for other instruments, models and experiments in support of the **BOREAS** objectives. In this paper we present a preliminary evaluation of the **AVIRIS** data collected at **BOREAS** in the terms of the **AVIRIS** derived parameters: water vapor, leaf water and apparent **spectral reflectance**.

2. WATER VAPOR, LEAF WATER AND REFLECTANCE

AVIRIS data were flown over the Old Jack Pine (**OJP**) site at 53.88 degrees north latitude and 104.92 degrees west longitude on July 21 1994 at 16:55 UTC (Figure 1). These data including the data over the **SSA OJP** site were calibrated from **AVIRIS** measured signal to **upwelling** spectral radiance (Figure 2). From the **upwelling** radiance the atmospheric water vapor was derived with a nonlinear least squares spectral fitting algorithm (Green et al., 1991, 1993) employing the **MODTRAN** radiative transfer code (Berk et al., 1989). For the **SSA OJP** site an abundance of 23.8 + -0.5 **precipitable** mm was determined (Figure 3). The algorithm was applied to the entire **SSA OJP AVIRIS** scene (Figure 4). A range of water vapor from 22.5 to 25.5 **precipitable** mm was mapped. Absorption of leaf liquid water was simultaneously derived with the water vapor with the water vapor algorithm. At the **SSA OJP** a value of 2.6 + -0.1 equivalent path transmittance leaf water was required (Figure 5). Values from 0.0 to 4.5 mm of equivalent path transmittance leaf liquid water were derived for the entire **AVIRIS** data set (Figure 6). Over areas of open water the derived water vapor is high and leaf water is low due to the dominance of multiple scattered light and minimal surface reflectance at 940 nm in the **AVIRIS** spectrum. Using the **derived** water vapor in conjunction with **AVIRIS** based estimates of the aerosol scattering the **upwelling** spectral radiance for the **SSA OJP** site measured by **AVIRIS** was inverted to apparent spectral reflectance (Green, et al., 1990, 1993) (Figure 7). Examination of the inverted spectrum shows good **agreement** with that expected for coniferous vegetation spectrum.

3. CONCLUSION

In 1994, **AVIRIS** measured images of **upwelling** spectral radiance for **BOREAS** during 8 different flights including both **southern** and northern areas. Spectral fitting and inversion algorithms were applied to spectra measured over the **SSA OJP** region on July 21, 1994 to **evaluate** the calibration and quality of the **AVIRIS** data. Water vapor, leaf liquid water and apparent surface

reflectance were directly derived from the **measured** spectra indicating good calibration. **Based** on this **AVIRIS** calibration, **research** may **proceed** with the derived atmospheric and surface parameter to address the objective of BOREAS.

4. FUTURE WORK

AVIRIS derived atmospheric and surface parameter will be compared to equivalent parameter measured by in situ **instrumentation**. Data measured spanning the eight **AVIRIS** flights and two regions will be further evaluated with **respect** to calibration and inter comparability.

5 ACKNOWLEDGMENTS

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6. REFERENCES

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Green, Robert O., **James E. Conel**, **Jack S. Margolis**, **Carol J. Bruegge**, and **Gordon L. Hoover**, 1991, "An inversion Algorithm for Retrieval of **Atmospheric** and leaf Water Absorption From **AVIRIS** Radiance With Compensation for Atmospheric Scattering," **Proc. Third AVIRIS Workshop**, **JPL** Publication 91-28, pp. 51-61.

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7. FIGURES

Figure 1. **AVIRIS** image of SSA Old Jack Pine region.

Figure 2. **Upwelling** spectral radiance measured by **AVIRIS** for the Old Jack Pine site on 21 July 1994.

Figure 3. Nonlinear least squares spectral fit for determination of water vapor.

Figure 4. Image of Water vapor over the SSA Old Jack Pine site.

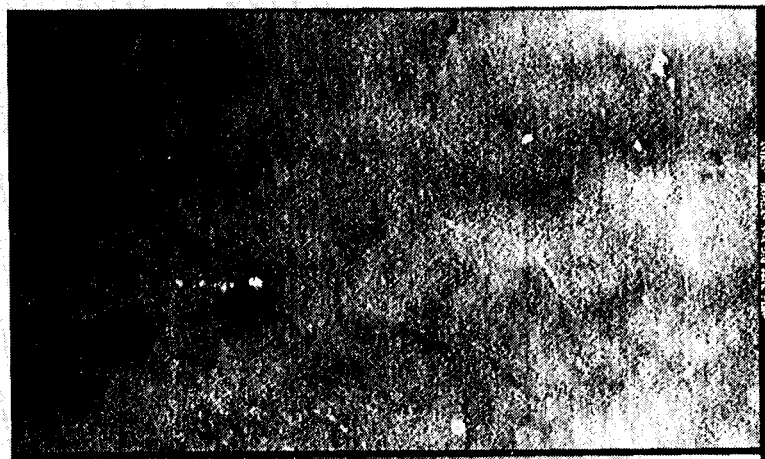
Figure 5. Nonlinear **least** squares spectral fit for determination of **absorption** due to leaf liquid water.

Figure 6. Image of leaf liquid water absorption derived from **AVIRIS** spectral imagery.

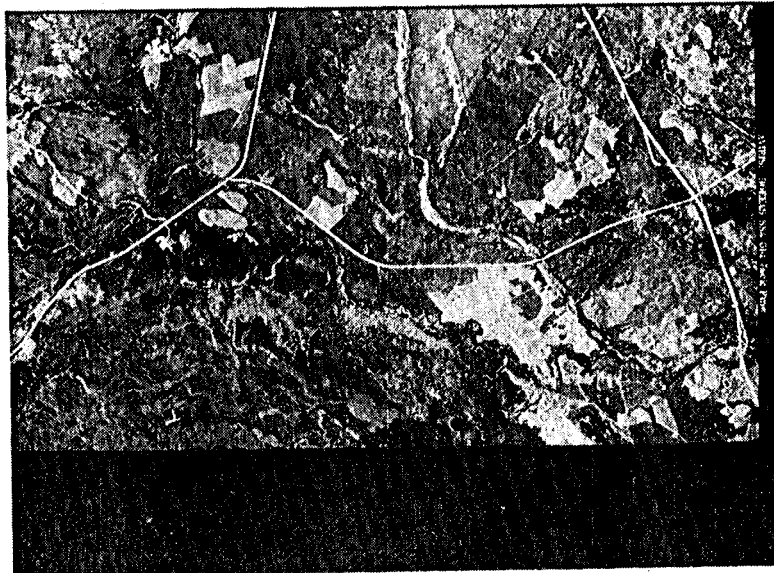
Figure 7. RTC derived surface reflectance for SSA **OldJack** Pine site from **AVIRIS** on 21 July 1994.



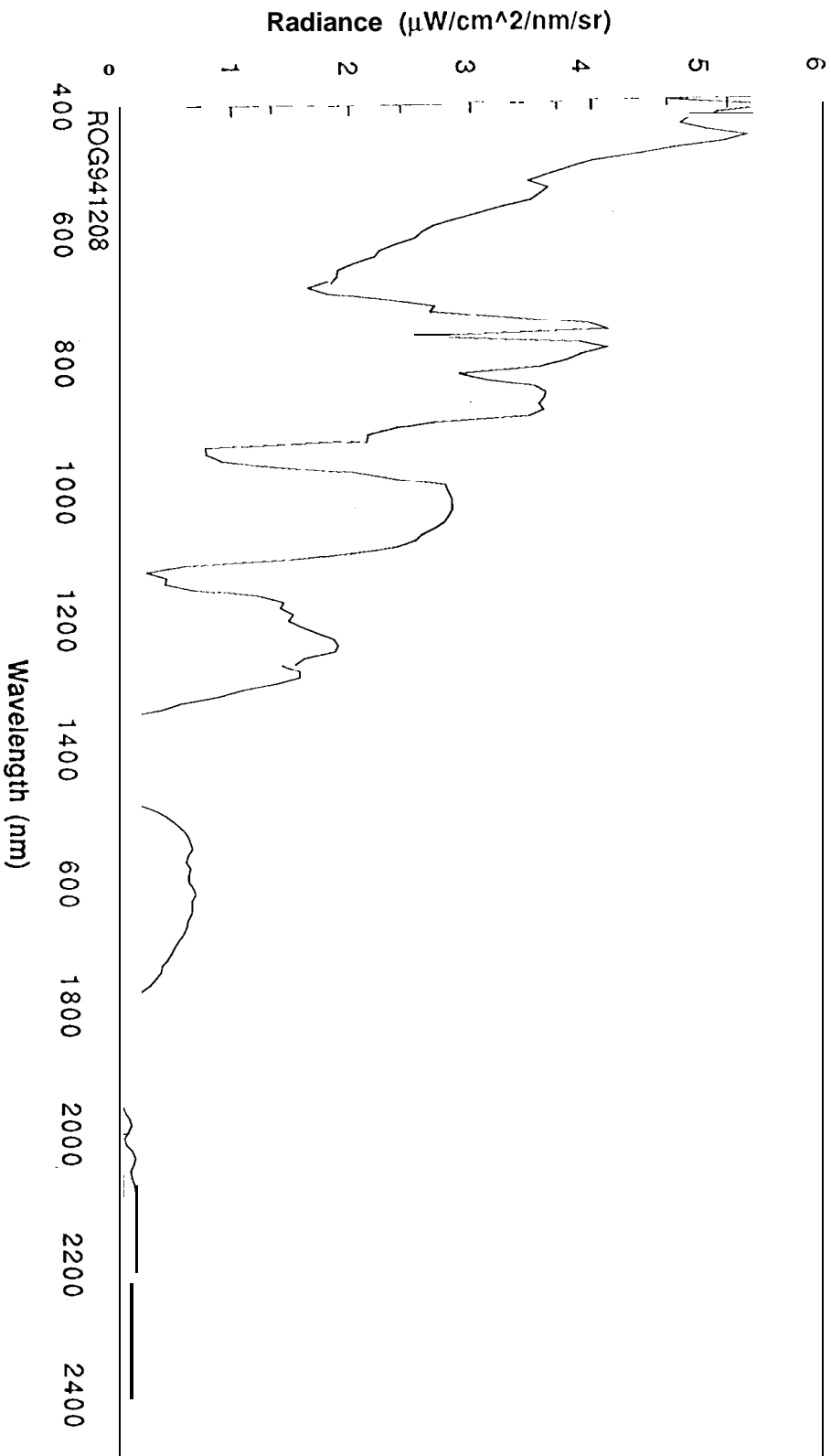
Top of Water Tank Road



Water Tank Road (left) to base of hill

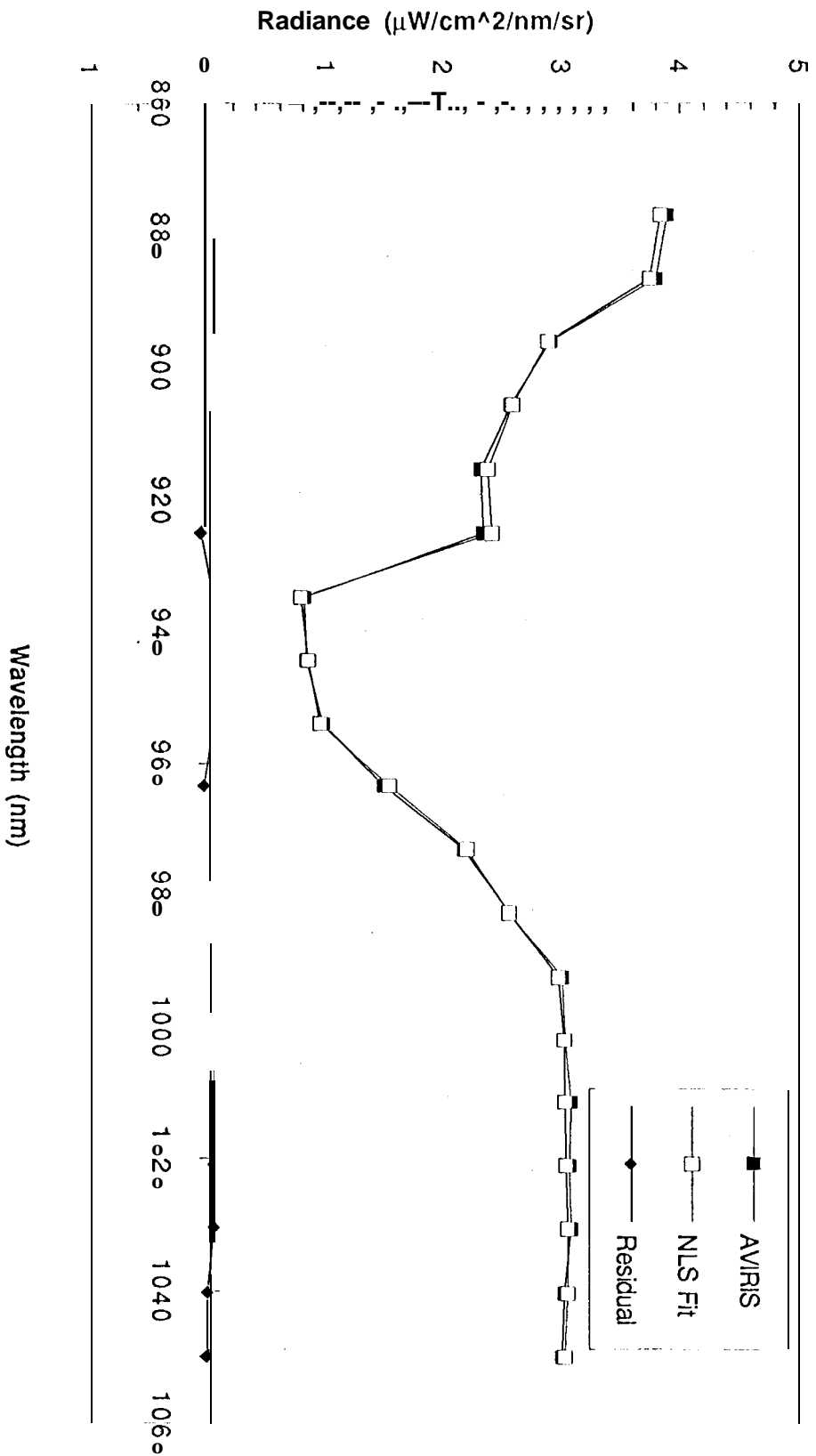


AVIRIS BOREAS SSA OJP Upwelling Radiance 21 July 1994



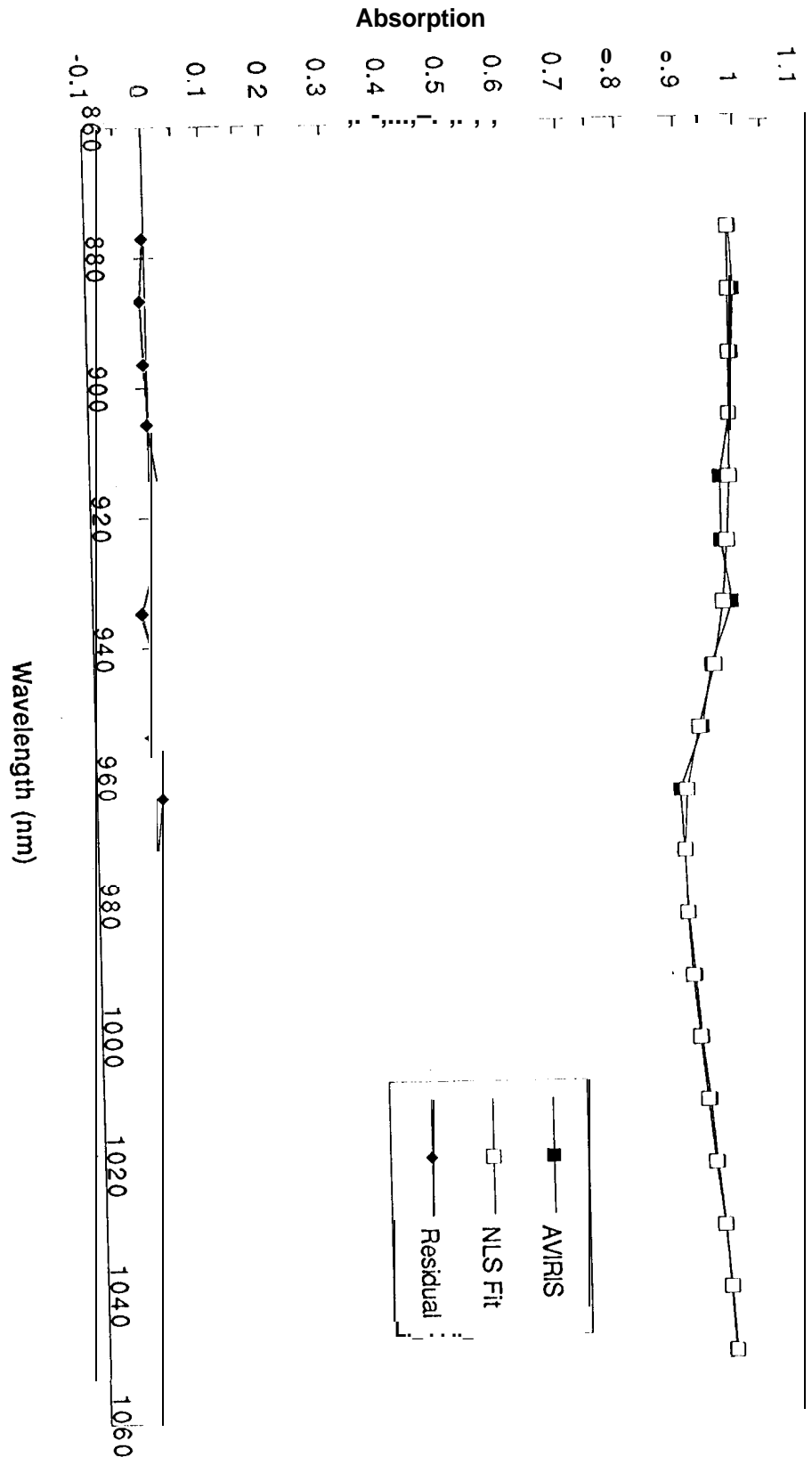
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AVIRIS BOREAS SSA OJP Water Vapor Fit



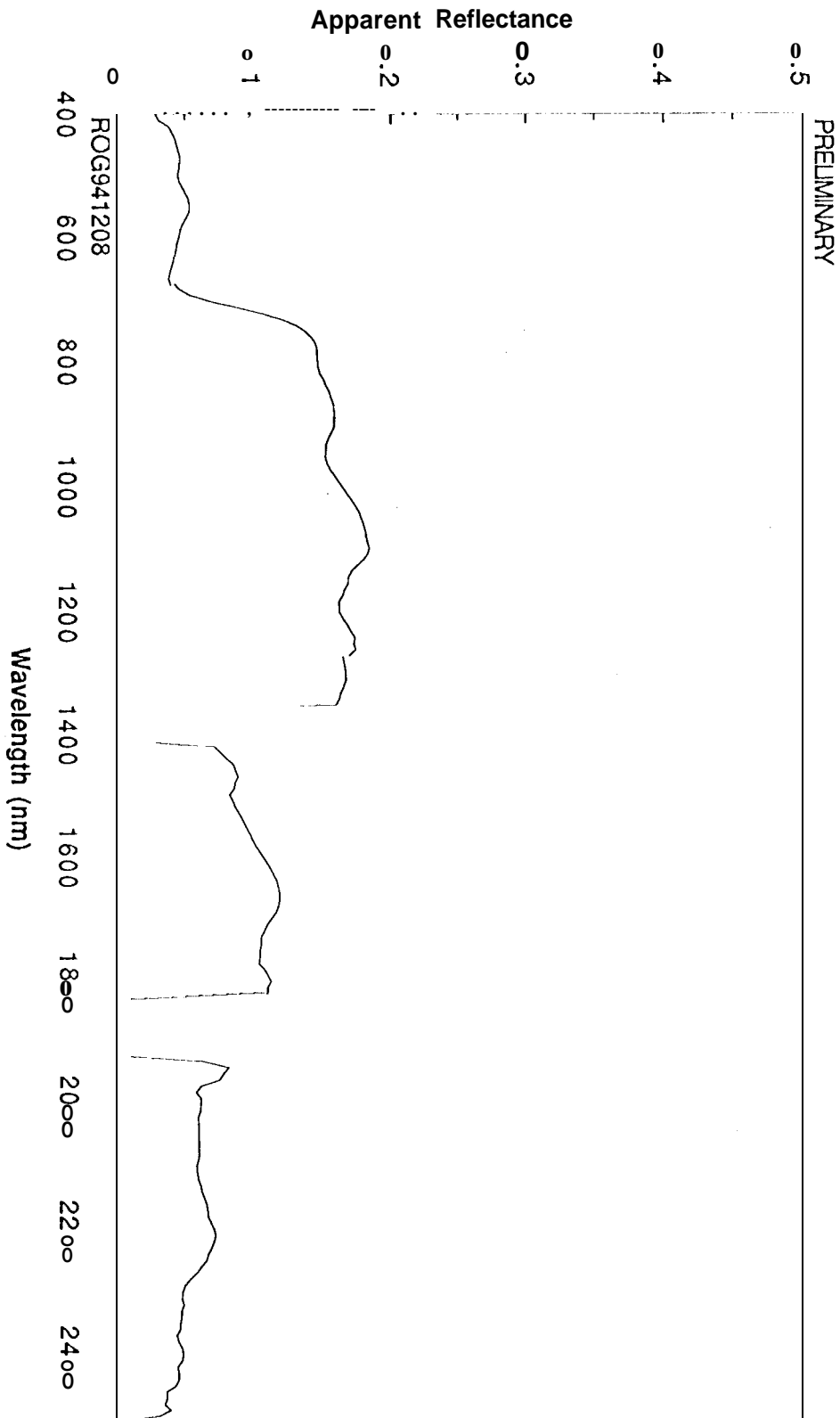
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AVIRIS BOREAS SSA OJP Lea Water Absorption Fit



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AVIRIS BOREAS SSA OJP Derived Reflectance 21 July 994



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