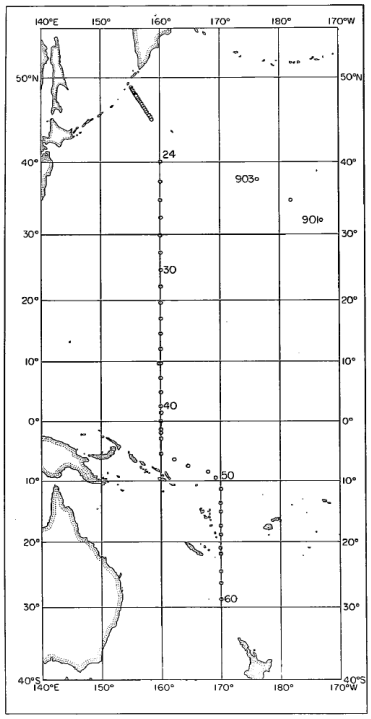
CRUISE REPORT: P13

(Updated JUL 2018)



Highlights

Cruise Summary Information

Section Designation	**P13** (aka: SAGA II [Soviet/American Gas and Aerosol expedition II])
Expedition designation (ExpoCodes)	**90AM19870501**
Chief Scientists	**Valentin Koropalov / Richard Gammon**
Dates	1987 MAY 01 - 1987 JUN 09
Ship	*R/V Akademik Korolev*
Ports of call	Leg 1: Hilo, HI - Wellington, NZ Leg 2: Wellington, NZ - Singapore Leg 3: Singapore - Hilo, HI
Geographic Boundaries	48° N 155° 0' 36" E 170° 1' 48" E 28° 52' 59" S
Stations	60
Floats and drifters deployed	0
Moorings deployed or recovered	0

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Links to Select Topics

Shaded sections are not relevant to this cruise or were not available when this report was compiled.

SAGA II

Physical, Chemical, and CTD Data Report
1 May 1987 - 9 June 1987Akademik Korolev

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S.I.O. Reference 88-10Sponsored by the National Science Foundation

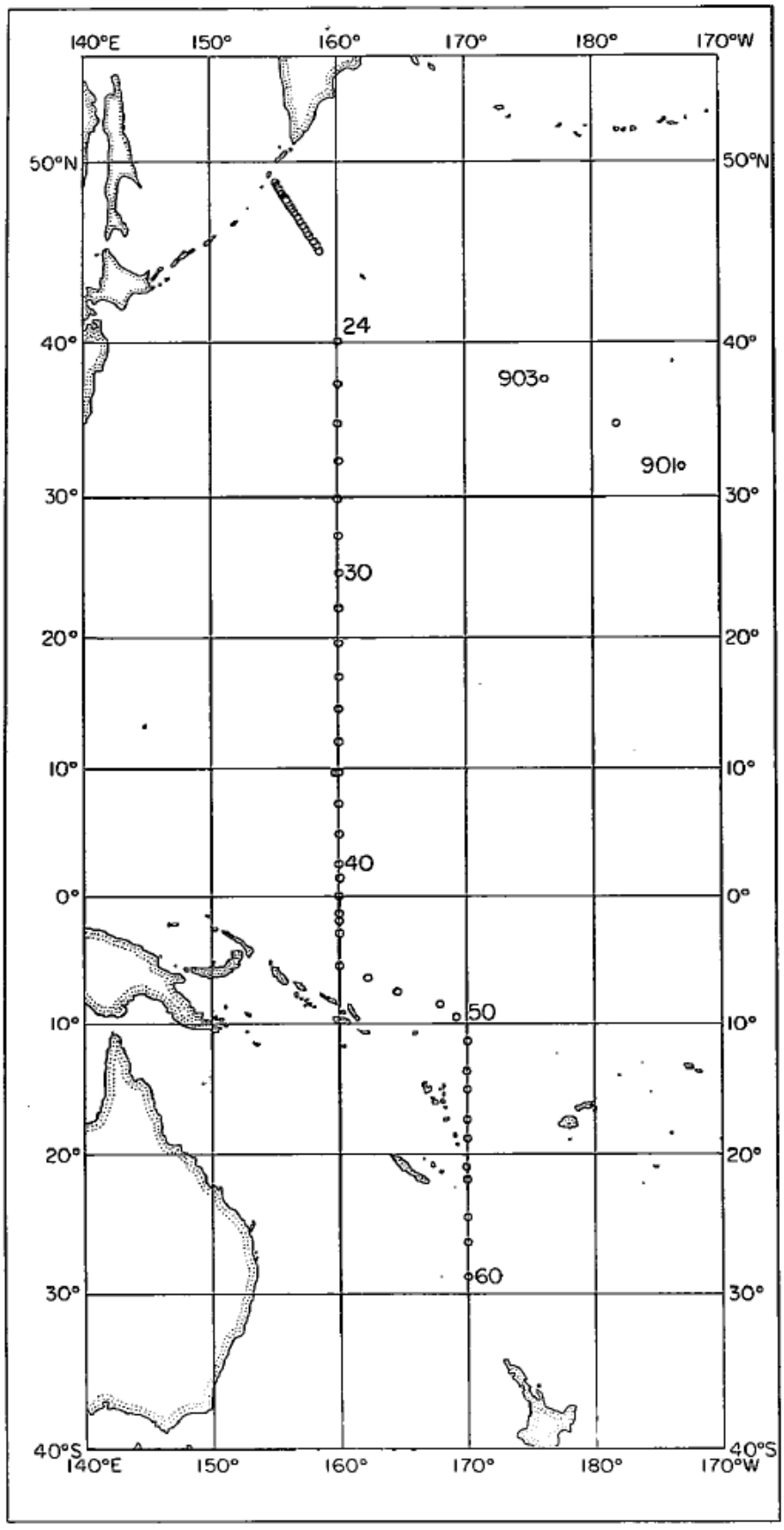
Grant OCE87-040379and the NOAA/TOGA Project Office

Approved for Distribution:

Edward A. Freiman, Director

1. INTRODUCTION

In May and June 1987, two sets of CTD/hydrographic stations in the western Pacific were occupied by the *Akademik Korolev* SAGA II expedition under the aegis of a joint U.S.S.R. - U.S. bilateral agreement. The major purpose of this expedition, headed by Drs. Valentin Koropalov and Richard Gammon of the Institute of Applied Geophysics in Moscow and NOAA/PMEL in Seattle, Washington, respectively, was to study the distribution of atmospheric gases and aerosols and of oceanic chlorofluorocarbons. The opportunity to carry out CTD/hydrographic work arose as a result of the latter study. The U.S. component of the hydrographic work, which is reported herein, was funded by the National Science Foundation and the NOANTOGA project office; all shipboard work was carried out by engineers and technicians from the Oceanographic Data Facility at Scripps Institution of Oceanography and Dr. Stephen Riser, with help from Russian scientists and technicians aboard the *A. Korolev*.


140°E
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The CTD/hydrographic work consisted of three parts: 3 test stations, 23 closely-spaced, deep stations in the northwest Pacific across the Kuril-Kamchatka Trench, and 37 shallow stations along 160°E and 170°E between 40°N and 28°S.

The purpose of the northwest Pacific section was to complete an earlier transpacific section (TPS47) at approximately 47°N (Talley, et al., 1988) with high quality, closely-spaced stations to the ocean bottom across the Trench. The section was purposely positioned as far north along the Kuril Islands as possible in order that transport estimates not be complicated by exchange between the North Pacific and Okhotsk Sea. Section data are being used in direct estimates of North Pacific heat and freshwater transports (in conjunction with the TPS47 results), in a study of western and northern boundary currents in the North Pacific, and as a source of information concerning late-winter conditions in the northwest Pacific.

The meridional transect along 160°E and 170°E was intended to be part of the ongoing TOGA hydrographic survey along this meridian. Extensive chlorofluorocarbon sampling along this section and a desire for close station spacing at the equator determined the station and bottle spacing.

2. DISCRETE DATA

2.1. Data Summary

Discrete samples were collected on 68 casts at 60 stations. Twenty-five casts were made to the ocean bottom, including one station at the equator (station 42), and 23 stations in the northwest Pacific; 2 deep casts were made at station 22 due to wire problems. Shallow casts were made at 6 of the northwest Pacific stations with 2 shallow casts at station 18. All casts along the "160°E" section were shallow with the exception of the equatorial station. A 24-place ODF rosette sampler with 2.2 liter Niskin-type bottles was used for all deep casts with more than 12 bottles. On shallow casts, 12 five-liter Niskin bottles were used in order to include chlorofluoromethane sampling.

Salinity samples were drawn from every bottle at every station. Oxygen and nutrients were sampled at all stations on the northwest Pacific section and at 26 of the 37 stations along the 160°E section.

2.2. Temperature and Salinity

Pressure and temperature for the discrete hydrographic tabulations were taken from the calibrated CTD data; calibrations are discussed in the following section. Reversing thermometers were mounted on 4 to 5 Niskin bottles on each cast to back up the laboratory CTD temperature calibration.

Salinity samples were analyzed at sea using one of two Guildline Autosal inductive salinometers. All salinities were calculated from conductivity using the 1978 practical salinity scale (UNESCO, 1981) and are tabulated to three decimal places. Wormley standard seawater batch P103 was used for calibration at the beginning and end of each station's analyses; hydrographic and CTD salinities are reported herein relative to P103 and have not been adjusted further.

Mantyla (1987) reports differences in salinities from one batch of standard seawater to another; batch P103 has not yet been included in his ongoing analyses. However, salinities from the deep portions of *Korolev* stations 20 and 21 can be compared with salinities at nearby deep stations made in 1985 (TPS47

stations 35 and 36; Talley et al., 1988) which were calibrated with standard seawater batch P96; the *Korolev* salinities (batch P103) are approximately 0.002%. higher than the TPS47 salinities (batch P96).

Bottle salinities were compared with CTD salinities to identify leaking bottles or salinometer malfunctions. Calibrated CTD salinities replace bottle salinities in the event of problems and are indicated by the letter "D" in this data report. CTD values were used at one or more levels on 22 stations including 5 stations at which CTD values only are reported.

2.3. Oxygen and Nutrients

Dissolved oxygen content was determined by the Winkler method as modified by Carpenter (1965), using the equipment and procedures outlined by Anderson (1971). Oxygen measurements are given in ml STP per liter of water at 1 atmosphere and at the potential temperature of the sample. A small number of oxygen outliers was discarded. The precision of the oxygen measurements within a single cast is 0.01 ml/l and the accuracy is 1%.

Silicate, phosphate, nitrate, and nitrite were analyzed using a Technicon autoanalyzer. The procedures are similar to those described in Atlas et al. {1971). Nutrient measurements are reported here in micromoles/liter at 1 atmosphere and 25°C, which is assumed to be the laboratory temperature. The precision of nutrient measurements (within a single cast) is better than 0.5% and the station-to-station, cruise-to-cruise accuracy is 2% to 3%.

3. CTD DATA

3.1. Processing Summary

Seventy-one CTD casts were completed using a rosette sampling system equipped with ODF CTD #1 (a modified NBIS Mark III), which was employed exclusively for all CTD casts. The CTD used on this expedition sampled in situ pressure, temperature, conductivity, and dissolved oxygen at a rate of 25 Hz. The CTD data were initially processed into a filtered, one-second average time-series during the data acquisition. The pressure and platinum resistance thermometer (PRT) temperature channels were corrected using laboratory calibration data applied in a model consistent with known sensor characteristics. The conductivity channel was calibrated to salinity check samples acquired on most casts.

The CTD time-series data were then pressure-sequenced into two-decibar pressure intervals.

3.2. CTD Laboratory Calibrations

3.2.1. Pressure Transducer Calibration

The CTD pressure transducer was calibrated pre- and post-cruise in a temperature-controlled bath to the, ODF Ruska Model 2400 deadweight-tester pressure standard (accuracy 0.01%). Thermal and mechanical hysteresis and thermal response- time were observed as a routine part of pressure calibration. Pressure transducer error was measured by increasing the pressure in a series of step from 0 psi to a maximum pressure, then decreasing by the same steps back to 0 psi. There were at least two pressure calibrations both pre- and post-cruise: full-scale to 8830 psi at nominally 0-1°C, and to 2030 psi at nominally 20-25°C.

The transducer thermal response-time was derived from the pressure response to a thermal step-change from 23 to 0°C.

3.2.2. PRT Temperature Calibration

The CTD PRT temperature transducer was calibrated pre- and post-cruise in a high-precision temperature bath to a Rosemount standard platinum resistance thermometer. The resistance of the platinum standard was measured by an NBIS model ATB- 1250 automatic resistance bridge. The transfer standard (the PRT-bridge system) is checked frequently at low temperature against the triple point of water, employing at least two different triple point cells. Transfer standard results are also compared to the triple point of diphenyl ether (26.8685± .002°C) to provide a check at warmer temperatures. The CTD temperature error was observed at approximately 1, 6, 15, 21, and 21°C.

3.3. CTD Data Processing

3.3.1. CTD Data Acquisition

Seven channels (pressure, temperature, conductivity, dissolved oxygen, elapsed time, altimeter, and CTD power-supply voltage) were acquired at a data rate of 25 Hz. The FSK CTD signal was demodulated by a NBIS Mark Ill deck unit and output over an RS-232 port at 9600 baud to a computer system assembled by ODF personnel (SB-180). The system CPU is an 8-bit Hitachi HD-64180 running at 6 mHz.

Data acquisition consisted of generating a filtered one-second time-series and storing this data on hard disk, then later on 3.5 inch floppy disks. Data calculated from this time series were reported and plotted during the cast. A ten-second average of the time- series data was calculated for each water sample collected during the data acquisition.

To generate the one-second time-series, the raw CTD data were initially subjected to absolute value and gradient filters to remove spurious points. The raw conductivity and pressure data were then passed through an exponential low-pass filter with time constant of 300 milliseconds to match the time response of the PRT. Pressure, temperature, and the lagged conductivity were then passed through a second, similar filter with a time constant of one second. The data were decimated to a 1 Hz rate and stored on disk for further processing. On shore, the stored data were transferred to an Integrated Solutions, Inc. (ISI) Optimum V computer system, where the bulk of the processing was performed, including re-applying laboratory pressure and temperature calibration data.

3.3.2. Additional Processing

The 0.322 inch (approximately 8 mm) diameter conducting wire used for this work could not be properly wound on the CTD winch provided by the *Akademik Korolev* as that winch was set up for 10 mm wire. It was a foregone conclusion that the conducting wire would eventually experience electrical failure. Fortunately, the deep work was essentially complete when the failure occurred. However, damage to the wire prior to failure produced small (typically 0.003-0.005 psu) spikes in the salinity trace from noisy conductivity and temperature data on some of the deeper casts. This noise was low amplitude and thus not rejected by the real-time filter algorithms. A spike filter was employed to remove most of this large temperature and conductivity noise from the time-series data. The down-trace (or up-trace, where appropriate) portion of each time-series was then pressure- sequenced into two-decibar pressure intervals, at which time a "ship-roll" filter was also applied to disallow pressure reversals. Deep potential temperature-salinity relationships were examined for consistency and to determine calibration problems.

3.3.3. CTD Dissolved Oxygen Data

The dissolved oxygen channel was not processed beyond averaging the raw oxygen current. Adequate numbers of high-quality check samples were collected to make calibration feasible, but processing must await additional software development and availability of funds.

3.4. Pressure, Temperature, and Conductivity Corrections

A maximum of 24 salinity check samples were collected on each cast. One or two racks of deep-sea reversing thermometers (DSRT's) were also used on each cast to provide additional information in the event of a shift in PRT calibration. As post-cruise temperature calibration of the CTD showed less than a 0.5 millidegree change from pre- cruise data, these DSRT data were not processed or used. A ten-second average of the CTD time-series at bottle-trip time was calculated for each sample. The resulting data were then used to provide basic in situ temperature and pressure data for the sampled levels, and in combination with the bottle salts, to derive CTD conductivity calibrations.

3.4.1. CTD Pressure Corrections

The pre- and post-cruise pressure calibrations were compared and showed no significant differences. As there were more points measured during the post-cruise calibration, these corrections were applied to the CTD data. The shipboard-processed pressures, corrected by the same pressure response model in a somewhat different mathematical form and using the pre-cruise calibration data, differ from the revised calibrated pressures by less than one decibar.

3.4.2. CTD Temperature Corrections

As there were no significant differences nor any apparent drift, the pre- and post-cruise temperature calibration data were averaged by lilting the combined sets to a second-order polynomial. Actual calibration points differ from the smooth curve typically by 0.0003°. The polynomial was then used to correct all temperatures. The precision of the CTD temperatures is estimated to be ±.001°C.

3.4.3. CTD Conductivity Corrections

Check sample conductivities were calculated from the sample salinities and from the corrected CTD pressures and temperatures. The differences between sample and CTD conductivities were fit to CTD conductivity using a linear least-squares fit. Values greater than two standard deviations from the fit were rejected. No conductivity slope correction was required.

CTD conductivity offsets were calculated for each cast based on the bottle minus CTD differences. The offsets were manually adjusted after carefully evaluating bottle salinity analytical problems {where laboratory temperature changes, poor standardization, or other problems made the CTD-bottle comparisons suspect), and employing deep T-S relationships as an additional guide. Conductivity offset corrections for shallow casts were determined from adjacent deep casts, or, if there was no deep cast, from the conductivity differences averaged over several stations.

3.5. General Comments

There were 71 CTD rosette casts of which 3 were test stations and not processed. At least one pressure-sequenced CTD data set exists for each CTD station, and there is also a second set for each station that had both shallow and deep casts. Three casts are available for Station 18, on which two shallow casts were taken. Only primary casts are included in this report. ODF normally reports CTD data taken· while lowering the CTD in order to produce the most synoptic view of the water column. However, if the quality of data taken during the recovery is significantly better, then that data is reported. In this data set, a total of fourteen up-casts are reported instead of down-casts: 1-1, 2-1, 5-1, 5-2, 6-1, 7-1, 12-1, 12-2, 13-1, 14-1, 19-1, 28-1, 35-1, and 38-1, where the first number is the station and the second is the cast.

Multi-level gaps are usually a result of audio tape changes. Gaps at more- than two adjacent levels occurred at stations 1-1, 2-1, 5-2, 6-1, 12-1, 18-1, 19-1, 22-1, and 22-2. Due to a bug in the real-time processing software for the SB-180, extraneous data points may have been introduced into some of these gaps. Intermittent single-level gaps in the data are due to removing ship roll effects, varying CTD velocity through the water column, and/or pressure sequencing of time-averaged data.

Non-bottle-trip stops and/or yoyos occurred on a few casts. The effect after pressure-sequencing is· a possible discontinuity in the pressure-series data. Yoyos larger than 10 dbar or known pauses in the cast occurred at stations 12-1, 13-1, 55-1, 56-1, and 60-1.

The 0.322 conducting wire failed during station 22 following the bulk of the deep stations on the northwest Pacific section. Station 23 therefore did not extend to the ocean bottom. The single deep cast along the 160°E section, at the equator (station 42) was affected by wire problems; CTD data at pressures higher than 2192 dbar were discarded.

4. DATA TABLES

CTD and bottle data are listed together for each station. CTD data are reported at selected standard intervals chosen from the processed 2 dbar pressure series and smoothed over 20 dbar using a Gaussian filter. At stations with multiple CTD casts, only the first is reported. Salinity was calculated as described above. Potential temperature referenced to 0 dbar and potential densities referenced to 0, 2000 and 4000 dbar are listed, as is specific volume anomaly (SVA) and sound velocity. The 1980 equation of state was used (UNESCO, 1981). Dynamic height in dynamic meters was calculated by integrating from the sea surface. If there was a missing temperature and/or salinity at the sea-surface, values at the surface were linearly extrapolated from those below. Brunt-Vaisala frequency, N, was calculated from the slope of a least squares fit of a straight line to specific volume anomaly over 60 dbar centered at the desired pressure; Gaussian weighting was used in the fit. Because of the large interval over which N^2 was computed, no values were calculated at pressures less than 30 dbar. The large interval was necessary to reduce noise in the calculation; nevertheless, occasional negative N^2 values were obtained in the deep water. Negative values have been replaced by blanks in this report. Negative values occurred primarily when the absolute value of N^2 was less than $0.005\text{^}(\text{cph})^2$, corresponding to expected uncertainties in density of order 10^{-7} over 60 dbar.

Discrete data are reported at all observed depths and from all casts. Oxygen is reported in ml STP per liter at the potential temperature of the sample and nutrients are reported in micromoles per liter at 25°C. Potential temperature and potential density were calculated as for CTD data.

5. STATION PLOTS (not shown)

Potential temperature versus salinity and temperature/salinity versus pressure are plotted from the 2 dbar CTD series for all stations.

6. ACKNOWLEDGEMENTS

The acquisition and publication of this data set was funded by the National Science Foundation, Ocean Sciences Division, under Grant OCE87-40379. Funds for processing data along the 160°E section were provided by the NOANTOGA Project Office. Drs. Roger Lukas (University of Hawaii) and John Toole (Woods Hole Oceanographic Institution) were instrumental in obtaining the TOGA funding. Dr. Valentin Koropalov of the Institute of Applied Geophysics (Moscow) and Dr. Richard Gammon of NOAA/PMEL (Seattle, Washington) provided us with the opportunity to carry out this work on the *Akademjk Korolev*.

7. REFERENCES

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CCHDO Data Processing Notes

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Current Status: unprocessed

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