4) Chree, C.: "III. Some Phenomena of Sunspots and of Terrestrial Magnetism at Kew Observatory", *Phil. Trans., Roy. Soc.* **212** (1913) 75-116.

Discussion

Singer, S. F.: To what extent is the "build-up" in H preceding the main phase a function of your particular selection criterion, *i.e.*, "abrupt onsets"? In other words, would you observe this effect if you took, say, all magnetic storms, or all *SC* storms?

Chernosky, E. J.: I believed that the build-up will appear in other similar groupings. I have found the same trends with selections of the five quiet and disturbed days and with ten day sequences of non-disturbed days. Since about half the events included in the abrupt onset table shown are associated with sudden commencement and sudden commencement storms, I expect a similar table of sudden commencement storms will show the same results.

Parkinson, W. D.: Have you tried a super-imposed epoch analysis using days of high H as zero days? If so, do you find a definite increase in disturbance in days immediately following days of high H?

Chernosky: A study of change in H was made and it was found that an increase in C value occurred at time of H decrease. It was preceded by a decrease in C value showing more quiet before an H decrease. Studies of high H values are being considered and some tentative ones have been made but the study is incomplete.

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I-1-4. Characterictics of Telluric Current at Land and Sea Based Stations

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Telluric current activity as observed at land based stations tend to display a pronounced principal direction effect. At stations located near the coast the direction tends to be perpendicular to the shoreline, suggesting a pronounced geological control of the directional aspects of the activity.

The writer has operated telluric current recording systems at many sites in the Tanana Valley of Alaska. This valley lies generally parallel to the auroral zone and a degree or two to the south. Hodograms of the disturbance activity in this region as recorded over periods of say 24 hours by continuously operating X-Y plotters are completely filled in ellipses with axis ratios of 5 or 10 to 1. Only during period of major disturbances does the recording pen trace excursions exterior to this well formed ellipse. The direction of the major axis in the Tanana Valley ranges from geographic north-south to about 35° counterclockwise from this orientation. Of seventeen sites occupied near College only one displayed a principal direction to the northeast. There seems no obvious explanation of this principal direction either in terms of geomagnetic phenomena or geological structure.

Correlation of telluric current and magnetic amplitude activity is very high. Monthly correlation coefficients between the daily average of the magnetic A figures and the daily average of the 3-hourly scalings of the telluric current amplitude for several months are all above 0.9. This statistical result is also substantiated by day to day subjective examination of individual disturbances.

The form of *D* and *H* magnetic traces and N-S telluric current traces for College were compared daily on a subjective basis for several months. All traces were made at 3 in/hr, thus presenting considerable detail and facilitating the comparison. Only N-S telluric current traces were used because of the great similarity between the N-S and E-W records. In general the *D*-trace or the *H*-trace, but not both, would tend to be similar in form and in time phase with the telluric current trace. During some storms the magnetic and telluric current traces shift in and out of time phase. Fluctuations with periods of say 5 to 10 minutes may move upscale simultaneously at the beginning of a storm and gradually shift out of phase over a period of an hour or two. This may occur with either the *D* or *H* trace.

The above phenomena suggest the need for simultaneous telluric current and magnetic measurements in a region of near homogeneous geological structure such as the polar sea.

Telluric current and magnetic activity were recorded on Arctic Drifting Station Charlie during the epoch Oct.-Dec. 1959, when the floe was located about 500 miles northwest of Point Barrow. The magnetograms were made with an Askania variograph and the telluric current records with Esterline-Angus recorders and transistor amplifier. Lead electrodes were suspended just below the ice at a spacing of about 1 mile.

The telluric current records do not display the principal direction effect characterictic of land based observations. Subjective inspection of the two perpendicular traces does not reveal a continuing similarity of form and hodograms based on scaling of selected storms extend into all quadrants. On at least one occasion the telluric current was directed southward of the quiet day trace for a period of more than an hour.

Based on a subjective examination of the records, the telluric current and magnetic amplitude activity show the same correlation as at land based stations. In addition there is a pronounced directional correlation. When the rotation of the floe resulted in a near alignment of the N-S electrodes with the magnetic meridian the N-S and *D* traces were essentially identical in form end in time phase. The same was true of the E-W and *H* traces. Also, the direction of the electric current in the sea was such as to contribute to the observed change in the magnetic field.

The penetration of the telluric currents was measured by lowering a pair of electrodes to a maximum depth of 4,500 ft and recording simultaneously with another pair vertically above at the surface. Comparison of fluctuations of 2 to 5 minute period show no measurable attenuation of such disturbances to this depth. This result corresponds with Cagniard's theory concerning the depth of penetration.

The contribution of the telluric current in the sea to the magnetic disturbance at the surface may be calculated on the assumption of an infinite current sheet of uniform density and of thickness equal to the sea depth. Calculations for several examples show that from one-third to one-half of the magnetic change was due to the electric current in the sea at station Charlie where the depth was about 2,250 meters.

During one very quiet period telluric current micropulsations of about 70 cycles/min (<1 sec period) were recorded on station Charlie.

Most of the above observations were substantiated on arctic drifting station Arlis I during the epoch Jan.-Mar. 1961. Here the electrode positions were shifted when necessary to maintain the desired orientation with the magnetic meridian. The form and direction of the telluric current and magnetic disturbances corresponded to those observed under the similar conditions on station Charlie. However, the depth of the sea was only about 400 meters during these observations on Arlis I. Calculations of the sea current contribution to the magnetic disturbance indicate a contribution of about 16%.

Visual observation of active overhead auroral arcs with rapid motion of structure along the arc was noted on several occasions to correlate with parallel telluric currents in the sea. No case was observed in which the current and arcs were not essentially parallel.

A Rubidium Vapor Magnetometer was operated both as a total field recorder and also at high sensitivity to record micropulsations during extremely quiet periods. At the latitude of Arlis I the magnetic field is nearly vertical and thus the record is essentially an *F* trace. It was observed on several occasions that quiet auroral arcs near the zenith and moving in a given direction perpendicular to their length were always accompanied by a continuous increase or decrease in the total field, thus indicating an electric current along the arc.

Magnetic micropulsations of about 80 cycles per minute were regularly recorded during otherwise very quiet periods. These micropulsations frequently displayed the "pearl type" form. No circuitry was available for rejecting the large, long period disturbances.

These studies will be extended on Arlis II. It is planned to record auroral forms in detail in addition to the telluric current and magnetic recording.

Discussion

Rikitake, T.: I wonder if you measured the conductivity of sea water.

Hessler, V. P.: I measured the conductivity of the surface sea water with improvised equipment and found it to be 28 ohm centimeters, as compared to a published figure of 25 ohm centimeters.

Parkinson, W. D.: You said that the currents in the water are not attenuated with depth. Is this consistent with eddy current theory, assuming a line source of the field?

Hessler: The determination was made for fluctuations of perhaps five minute period. Calculation for this period indicates no appreciable attenuation to the 1,500 meters depth involved in the experiment. As I understand Cagniard's development, the calculated penetration is independent of the form of the external driving function.

Cardus, J. O.: When you had the two sets of electrodes, one in the surface and one down below, did you try to ascertain the existence of a vertical component of the earth currents?

Hessler: Yes, I did and recorded some activity which I interpret as entirely due to offset of the depth electrode because of ocean currents and drift of the sea ice.

Troitskaya, V. A.: What was the range of variations in mV/km in earth currents?

Hessler: I normally operate recording equipment at College at a range of 1,200 mV/km. This gives some detail on quiet days and records most of the features of even major storms. Similar results are obtained on the arctic floe station with ranges from 100 to 200 mV/km.