Table 1. Gravity anomalies possibly attributable to meteoritic origin of terrain features.

Location	Amplitude (milligals)		Reference
	Major negative anomaly	Minor residual positive anomaly	
Canada			
Canadian Holleford	−(1–2)	1	(*3*)
Brent	−(3–4)	1	(*3*)
Deep Bay	−12		(*3*)
United States			
Arizona	−¾	¼	(*4*)
Texas	−1½	½	

associated large negative gravity anomalies.

Harding (*4*) has made a gravity survey over the Barringer (Arizona) meteorite crater and has combined the data with results of a vertical-component, magnetometer survey made by J. J. Jakowski. Again, there is a regional negative anomaly of about ¾ milligal, centered over the crater and the zone of brecciation. There is also evidence of a local positive residual gravity anomaly of about ¼ milligal on the southwest flank of the crater. This could be caused by a fairly large fragment of the original meteorite which did not shatter or vaporize. Additional evidence in support of this assumption is found in the 30-gamma positive magnetic anomaly associated with, although offset slightly from, the gravity anomaly. Magnetic data are very useful as corroborative evidence in interpreting the geologic significance of gravity data. Consequently, it is desirable to conduct both magnetic and gravity surveys over features of this type in order to establish criteria for determining their terrestrial or extraterrestrial origin.

Data obtained within the next few years by unmanned and manned lunar missions will increase our understanding of the origin and history of the moon. How much information we obtain and how correctly we interpret the data that we do obtain will depend upon our ability to determine early in the lunar-exploration program the origin of specific features of the moon's surface. To gain this ability, we must first determine and catalog the geologic and geophysical properties of terrestrial features caused by the impact of meteors. We must also study, in this connection, the characteristics of volcanic and cryptovolcanic features, to establish a valid basis for making terrestrial-lunar comparisons. However, until the formational mechanics of analogous terrestrial features and the effects of various genetic processes on the field of force and on other physical properties are known, we will have no valid basis for making comparisons of this kind, and for interpreting regional or local geophysical data for the moon. Thus, we must understand pertinent terrestrial phenomena before we can hope to make an effective analysis of empirically derived lunar data, as a sound basis for conducting research on the surface of the moon.

Geologists have done much detailed field and laboratory work on terrestrial features that are known or suspected to be the result of meteoritic impact or of volcanic and cryptovolcanic processes. This work has resulted in the proposal, and general acceptance, of a number of basic geologic criteria for classifying such features. These criteria pertain to such diverse factors as topography, brecciation (on both a macro and a micro scale), intense shearing, and the presence of shatter cones, glass, and coesite or other minerals that form at high pressures. At present, no similar set of criteria based on geophysical data is generally recognized.

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Astaxanthin in the Cedar Waxwing

Abstract. *The pigment on the secondary feathers of the cedar waxwing* (Bombycilla cedrorum) *is deposited as an amorphous layer upon a supporting medullary structure. The pigment was extracted with alkali and analyzed by chromatographic and spectrophotometric methods. The results indicate that the pigment is astacene (3,3′,4,4′-tetraketo-β-carotene), the oxidation product of astaxanthin.*

Among the passerine birds, one of the more unusual and conspicuous deposits of pigment occurs in the cedar waxwing, *Bombycilla cedrorum*, where it occurs in the form of a waxy, red appendage on the tips of the secondary wing feathers (Fig. 1). The appendage has a waxy sheen, and is characterized by a bright dorsal and a dull ventral surface. Arvey (*1*) reports that the pigment occasionally occurs on the tips of the rectrices of this species. In a closely related form (*B. garrula*), the tips may be yellow. Tips are reported with about equal frequency in both sexes but are not found on all individuals in a population. Dwight (*2*) and Phillips (*3*) report the presence of the tips in the juvenal plumage. Arvey (*1*) states that available data show that the young of *B. cedrorum* lack the tips.

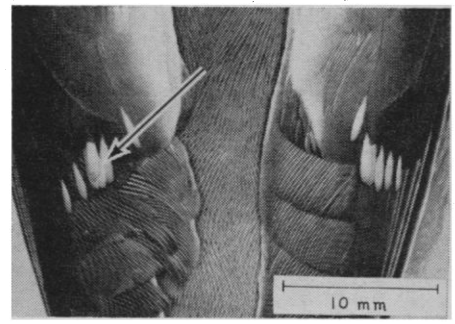

Fig. 1. Dorsal view of a cedar waxwing. Arrow points to pigmented tips on secondary feathers.

The object of this investigation was to determine the morphological relationship of the pigment to the feather, and the chemical nature of the pigment itself. To determine the morphological relationship of the feather and the pigment, tips were embedded in gelatin, sectioned on a freezing microtome, and prepared as dry mounts. A photomicrograph of a tip is shown in Fig. 2. The red pigment appeared as an amorphous cortical layer superimposed on a more structured medullary layer. Surrounding both layers was a transparent cuticle. The tip is essentially the flattened extension of the central rachis, similar to that in *B. garrula* as shown by Stieda (*4*). The structure is unique in feathers.

The nature of the pigment was determined by the method of Fox (*5, 6*). The pigment was not extractable in cold acetone, cold alkaline methanol, or hot pyridine. This may have been due to the impervious nature of the cuticular covering. Wingtips from the feathers of twelve birds were placed in hot (90°C) alkaline methanol. The hydrolyzate from this hot alkaline methanol was yellow-orange in color. The hydrolyzate was centrifuged and the supernatant was collected, diluted, and partitioned with petroleum ether. The

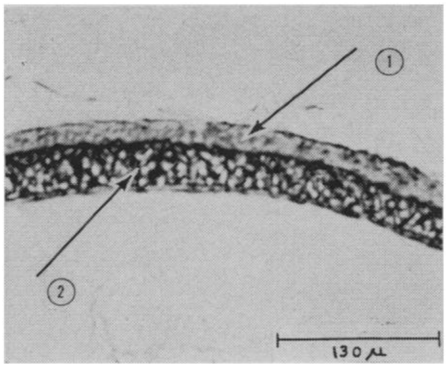

Fig. 2. Cross section of a pigmented wing-tip from a cedar waxwing. Arrow No. 1 points to the dorsal pigment layer. Arrow No. 2 points to the medullary layer.

pigment migrated to the epiphasic ether layer only upon acidification with glacial acetic acid. The petroleum ether fraction was then chromatographed on a column of magnesium oxide and celite (1:1). The column was washed with petroleum ether and a single colored zone developed. Samples of the pigment were also dissolved in pyridine. The absorption spectrum of the pigment was determined in both solvents on a recording spectrophotometer (Cary, model B). The results are shown in Fig. 3. The absorption spectra show maximum peaks at 470 mμ in petroleum ether and 490 mμ in pyridine. The results agree with those of Fox (*5*) for astacene (3,3′,4,4′-tetraketo-β-carotene), which is the oxidation product of astaxanthin (3,3′-dihydroxy-4,4′-diketo-β-carotene) (*7*). On the basis, therefore, of the extraction, chromatographic, and spectrophotometric properties, we conclude that the pigment in *B. cedrorum* is astaxanthin. It should also be noted that no other carotenoid was found in the pigmented tips of this species.

Astaxanthin has been isolated, and its oxidation product astacene has been

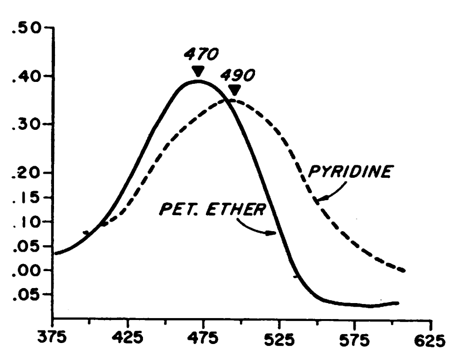

Fig. 3. Absorption spectra of astacene, from waxwings, in petroleum ether and pyridine. Ordinate, optical density; abscissa, wavelength in millimicrons.

derived, from extracts of the feathers and integument of several avian species (*8*). Fox (*5, 9*) reported these, and other carotenoids in the feathers, skin, and plasma of the roseate spoonbill (*Ajaia ajaia*), the American flamingo (*Pheonicopterus ruber*), and the James flamingo (*Phoenicoparrus jamesi*). Völker (*10*) and Fox (*5*) reported the presence of several other pigments in these species. Völker (*11*) has also isolated astaxanthin from the feathers of a shrike, *Laniarus atrococcineus.*

Fox (*5, 6*) has investigated the distribution and metabolic fate of the carotenoid pigments in the flamingo and the scarlet ibis (*Guara rubra*). The carotenoid found in highest concentration in these birds was canthaxanthin. Astaxanthin was also present but in lower concentration. In these species, the degree of pigmentation in the feathers and the integument was associated with the concentration of dietary carotenoids. The metabolic origin of astaxanthin is not yet completely understood. Fox (*5*) reports that even in diets containing yellow, but not necessarily red, plant carotenoids, astaxanthin was deposited in the feathers. The dietary precursor of astaxanthin and of canthaxanthin in birds has not been established. *B. cedrorum* feeds on a diet of wild fruit, flowers, and a wide selection of insects, both adult and larval. It is probable that the pigment precursor is dietary in origin.

The restriction of astaxanthin to the tips of the nine secondary wing feathers of the cedar waxwing poses several interesting questions concerning the origin, intermediary pathway and transport of the pigment, its mechanism of deposition, and its occurrence in fledglings and juvenals (*12*).

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Seismic Investigations of Seychelles and Saya de Malha Banks, Northwest Indian Ocean

Abstract. *Seismic refraction lines on Seychelles Bank confirm the presence of granite rock under a considerable portion of the bank. Saya de Malha Bank, also on the Mascarene Ridge, appears to be composed of volcanic rocks capped by coral. It is suggested that the two areas are structurally independent.*

In the fall of 1962, the vessels *Argo* and *Horizon* of the Scripps Institution of Oceanography were engaged in seismic refraction work in the Indian Ocean, as part of the International Indian Ocean Expedition. During this period, explosives were fired and refracted seismic waves were recorded in shallow water on Seychelles Bank and Saya de Malha Bank to determine the nature of the material making up the Mascarene Ridge.

The only previous work in the area was done during the Challenger Expedition, when one extremely short profile east of Mahé Island was shot and reported by Gaskell, Hill, and Swallow (*1*). The Challenger profile showed the presence of about 0.02 km of sediment or coral with a compressional-wave velocity of 2.4 km/sec; 0.13 km of material with velocity 5.58 km/sec; and beneath that, material with velocity 6.02 km/sec. Since the work was done within a few miles of the outcropping granite of Mahé, it was assumed that the material with the compressional-wave velocity of 6.02 km/sec was granitic and that with the velocity of 5.58 km/sec was probably weathered granite.

The positions of our stations LSD 20 and LSD 21 form a reversed profile; the eastern end of the profile is at the south tip of Silhouette Island, northwest of Mahé (Fig. 1 and Table 1). The line extends 42 miles west in the shallow water of Seychelles Bank. At station LSD 20, the structure is very similar to that reported previously.