



Recent Changes in the Plateau Region

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suppressing mere noises. Chiefly it seems to be the direction in which the walls run which acts on the mixed sounds as a prism does on the mixed waves of light; the roughness of the cliffs which acts acoustically as a Rowland grating does optically; and the super-position of several mirror echoes which gives a result analogous to that of a Michelson interferometer.

So far as I am aware, no one has reported these spectral or analyzed echoes as occurring on Mt. Desert, and it is certainly not generally known that the precipitous granite hills carved out by the glaciers in this region are peculiarly rich in these beautiful acoustic properties. They are much more numerous there and easier to elicit than in any other region with which I am acquainted. On the western side of the island I have found only a few spots with spectral echoes, although echoes of the ordinary or mirror type are perfect in at least two places on that side. On the cliff in *Somes Sound* a very sharply defined mirror echo is well known, but very little prismatic effect is obtainable. At *Echo Lake* there is also a well-known mirror echo; and there it is only necessary to go a few rods southward from the focus of the mirror echo, in order to obtain a fine spectral effect.

On the eastern half of the island there are no such sharp mirror echoes as those on the western side, for there are fewer smooth, vertical and isolated walls. There are, however, several splendid spectral echoes. The first to be found is on the trail up *Jordan Mountain* from *Asticou*, about two thirds of the way up. It comes across a gorge between two ridges. Even finer spectral echoes are obtainable at several places along the upper part of the cliff trail on the eastern face of *Jordan Mountain*, reflected from *Pemetie* and the *Bubbles*. But perhaps the best of all are those on the "goat trail" down the side of *Pemetie Mountain* to *Jordan Pond*. Sounds from there are reflected from the broken eastern face of *Jordan Mountain* and from the *Bubbles*. These spectral echoes are multiple, a succession of two or three distinct and separate returns.

In calling musical echoes it is best, in my opinion, to sing or rather shout a few successive notes, either a scale or arpeggio. Best of all is a bar of five notes which are associated with the "fire motif" in Wagner's opera of "*Die Walküre*."

Of course a considerable volume of sound helps; but it is not necessary to strain an ordinary voice; for distinct and repeated returns may be obtained even by a woman's voice. If a man's voice has in it any musical quality at all, the acoustic prism or grating picks out the harmonious elements and suppresses all mere noise. Thus a rather harshly shouted succession of notes comes back rich, sweet and full, again and again, and finally faint and far, but still

clear, as if it were the voice of some elf of the mountains way up among the crags.



Hi-yo, Hi-yo-ho. Hi-yo, Hi-yo-ho.

I can not resist repeating some of the lines of Emerson from the passage which Professor Forbes quotes at greater length. No scientific description could be truer, for the sounds even of a voice of little natural musical quality, as he says:

Softened are above their will,
Take tones from groves they wandered through
Or flutes which passing angels blew.
All grating discords melt,
No dissonant note is dealt,
And though thy voice be shrill
Like rasping file on steel,
Such is the temper of the air,
Echo waits with art and care,
And will the faults of song repair.

* * * *

The artful air will separate
Note by note all sounds that grate,
Smothering in her ample breast
All but godlike words,
Reporting to the happy ear
Only purified records.

I recommend the search for spectral echoes as a delightful motive for scrambles among these and other hills.

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RECENT CHANGES IN THE PLATEAU REGION

THE Plateau region, as used in this paper, refers to the plateau south and east of the Colorado River, extending eastward to the Rio Grande country of New Mexico and southward over the highlands of both New Mexico and Arizona to the Mexican line.

A close observation shows that a deep cutting began in this region some time in the early Pleistocene and continued uninterrupted till probably in the late Quaternary (Recent), when the incising process was arrested. Then there set in a refilling of the valleys which continued till our own time. And the valleys are now incising themselves again at a rapid rate.

Concerning the filling of the valleys, Dutton, who examined the region with Powell, 1878-1880, says:¹

¹ Dutton, C. F., "Tertiary history of the Grand Canyon districts," U. S. Geol. Sur. Mon. 2, pp. 228, 229; 1882.

Most of those lateral canyons . . . are slowly filling up with alluvium at the present time, but very plainly they were much deeper at no remote epoch in the past. The lower talus in some of them is completely buried, and the alluvium mounts on the breasts of perpendicular scarps. In some cases a smooth floor of alluvium extends from side to side of what was originally a canyon valley.

As an instance, when the first white people came to the Marsh Pass-Laguna Creek country and the Segi Canyon region in the Navajo country, 174 miles north-east of Flagstaff, Arizona, there was no Laguna Creek. The valley and canyon floors were a vast plain, dotted with lakes and swamps. A U. S. topographic map made of the region in 1881 shows no stream leading out of it. Hunting parties frequented the region to kill ducks in the swamps and marshes; and the government road led through the pass over the marshy flats, hence the name "Marsh Pass." Then Laguna Creek began to cut back from Chinle Creek thirty miles to the eastward. Year by year it extended its possessions till to-day it ramifies every part of the inner valley and the Segi canyons, has drained all the ancient pools, swamps and lakes, and has the whole country cut up with a maze of lateral, straight-walled chasms fifty feet or more in depth. And the Tokas Jay, the stream leading northward up the valley along the road to Marsh Pass from Moenkopi wash, and Pueblo Colorado wash at Ganado, 45 miles west of Fort Defiance, Arizona, will cut up those valleys and destroy their lakes and pools, as Laguna Creek has done in the Kayenta region, unless man brings about some means to stop their devastating process.

Many people, including the geologist, Herbert E. Gregory,² believe that the aggrading of the valley floors of this region was due solely to climatic changes—little rainfall and the action of the wind. They also believe that the cutting of the present valley fillings is due in the main to the overgrazing of the region and the making of paths and roads.

The factors above mentioned no doubt aided in building up or degrading the fluvial valley floors; but it would seem to the writer that possibly the main agent in causing the aggrading of the valley floors was man.

The Hopis (and occasionally the Navajos) of to-day build dams and ditches to direct the flood waters of the respective washes and also to prevent canyon cutting; also a series of check dams are often built along moderate slopes and along small washes to retard the run-off and to impound water for stock and house use. Occasionally the valley sides are terraced to prevent arroyo cutting. The dams, which are about five feet in height, are of earth and consequently have

² "Water resources of the Navajo country," U. S. Geol. Sur., Water Supply Paper 380, 1916, p. 100.

to be made annually. Though requiring a great amount of work, through this impounding of water and diverting of washes, water is furnished for much of their stock, and over 20,000 acres of land is irrigated.

In the long ago, when this region was densely populated, as has been shown by Messrs. Kidder and Guernsey,³ and by the writer,⁴ each little wash and flat had its village, and the water was carefully husbanded in the irrigation of the necessary fields and was impounded by reservoirs and check dams for village use. At the present time more than 90 per cent. of the flood waters escape down the washes. The escape of the flood water then was nil, and probably this condition existed for thousands of years. As evidence that such damming and diverting of water was practiced by the ancients, fragments of check dams of loosely piled stone arranged on sloping rock benches and on the terraced floors of the washes may be seen near many of the ruins of the ancient cliff houses and villages of this region (and these villages and cliff houses were numerous).

The triangular Laguna Creek area between Marsh Pass and Church Rock, eighteen miles in length and seven miles across its base at Church Rock, contains 202 ruins of villages, and the Cornfields region from Ganado southward down Pueblo Colorado wash valley to Sunrise Springs, a distance of seventeen miles, contains 173 ruins. This reduced the run-off to the minimum. As a result the *débris* brought down from the mesas by washes was left on the fields and deposited as fans over the valley flats. As no water ran down the main channels, they gradually filled up. Wind action no doubt played a part in filling up the valleys. However, there is no evidence that sand dunes were the main factors in closing any part of the streams of the region. On the contrary, their banks are clays, pond deposits (including layers filled with snail shells) and wash material. In time the drainage became wholly blocked, not because of a lack of rain sufficient to carry off the *débris*, but because man used the *accumulating waters for his own use*. Outrushing washes, descending from the higher areas, also now and then pushed their dry fans farther and farther across the region till the valleys were wholly dammed and the excess water impounded in shallow lakes. Then by this same process the valley flats were gradually aggraded. That this valley filling occurred since the coming of the villagers is evidenced by the presence of pottery, corn cobs, kitchen refuse and occa-

³ Kidder, Alfred Vincent, and Guernsey, Samuel J., "Archeological explorations in northeastern Arizona," Bulletin 65, Bureau of American Ethnology, Washington, 1919.

⁴ Reagan, Albert B., "Archeology of the Tuba-Kayenta region in Arizona," Trans. Kan. Acad. Sci., Vol. 30.