RECENT FIELD RESEARCH ON POTENTIAL METEORITE FALLS FROM THE METEORITE OBSERVATION AND RECOVERY PROJECT

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ABSTRACT

Results of seven years of field investigation of fifteen locales where the Meteorite Observation and Recovery Project (MORP) camera system observed possible meteorite falls are presented and discussed. The fall areas where meteorites are most likely to be recovered based on terrain and end mass are identified. No new meteorites have been recovered to date.

RÉSUMÉ

Les résultats de sept années de recherches sur le champ à quinze localités où le système de caméra du Projet d'Observation et de Recouvrement de Météorites (PORM) observe la possibilité de chutes de météorites sont preséntés et discutés.Les endroits de chutes où les météorites ont la plus grande chance d'être récupérés basé sur le terrain et le poids final sont identifiés. Aucune nouvelle météorite n'a été récupérée à date.

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Introduction. The study of meteorites provides an important source of information on planetary bodies which could not otherwise be obtained by Earth-based observation alone. At present most information about meteorite parent bodies in the solar system is derived from the petrological character of the meteorites. Additional information, such as the relationship between photometric mass, fragmentation, parent body locations and fireball densities may be gleaned, both directly and indirectly, only in cases where a fireball is photographed and meteorites are recovered from it (Bronshten, 1983).

To date, only three meteorites, Příbram (1959), Lost City (1970), and Innisfree (1977), have been recovered from camera network data with accurate pre-impact orbits. The latest of these was found from data obtained by the MORP camera system.

In addition recent information given by Halliday *et al.* (1990) suggests that some of the MORP falls may be genetically related asteroidal fragments, further motivating recovery.

As of 1984 some forty-six meteorites have been recovered in Canada (White and Pope, 1984). Efforts to obtain orbital and atmospheric flight data for a recovered meteorite resulted in the establishment of the Meteorite Observation and Recovery Project which operated from 1971 to 1985. The photographic MORP network recorded fireballs occurring over the prairie provinces in hopes of recovering meteoritic material associated with deeply penetrating fireballs. Details of the most promising individual events have already been published in the JOURNAL by Halliday, Blackwell and Griffin (1989), henceforth referred to as HBG 89. That work forms the basis for all investigations carried out in this paper.

Presented here is a summary of the authors' field work from the years 1985–1991, the purpose of which was to recover meteorites resulting from fireballs photographed by the MORP network.

We have investigated fifteen separate MORP falls in Alberta and Saskatchewan. Figure 1 shows the locations of the fall areas. We determined the most likely fall regions by estimated fall fragmentation along the flight, end heights and wind velocities at the fall, this information being provided in HBG 89 and by Halliday (personal communication, 1989).

For each fall, farmers were interviewed, given information pamphlets and shown samples of meteorites. Estimates of the total number of farmers in an area were made on the assumption that one of every three structures denoted on topographic maps represented an occupied farmstead. Within most of the areas surveyed an evaluation of surface rock density was made.

Results. The major results of each field campaign are summarized in Table I. The first column lists the name of the fall locality and MORP designation number as adopted in HBG 89. The second and fourth columns give the estimated impact point and date and time of fall respectively also from HBG 89. The third column gives the estimated terminal mass of the largest fragment of the fall from HBG 89. The fifth column lists the date(s) on which field work was carried out by us, while the sixth column gives the search area we adopted as most likely to produce results based on terrain and fall point. The seventh column lists the estimated number of farmers in the area of investigation with the actual number interviewed in parentheses. Table II, the second column summarizes the local terrain while the third column lists the extent of any actual physical search made for the fall. The last column gives a qualitative estimate of surface rock densities. The method of footsearching in open terrain involved separating each member of the search party by about 2–3 metres, placing the group in a line and then sweeping over the field in rows marked out by surveyor's tape.

Of general interest is the number of apparently promising leads which were followed up at almost every fall. As an example, one resident of the Edberg area said that he had noticed numerous strange rocks in his field shortly after the fall, but had dumped these in a local creek before learning of the potential fall. An afternoon searching the creek where he had placed the rocks demonstrated the difficulty in trying to unearth ten-year-old rocks from a massive rockpile, a "needle in a haystack" proposition.

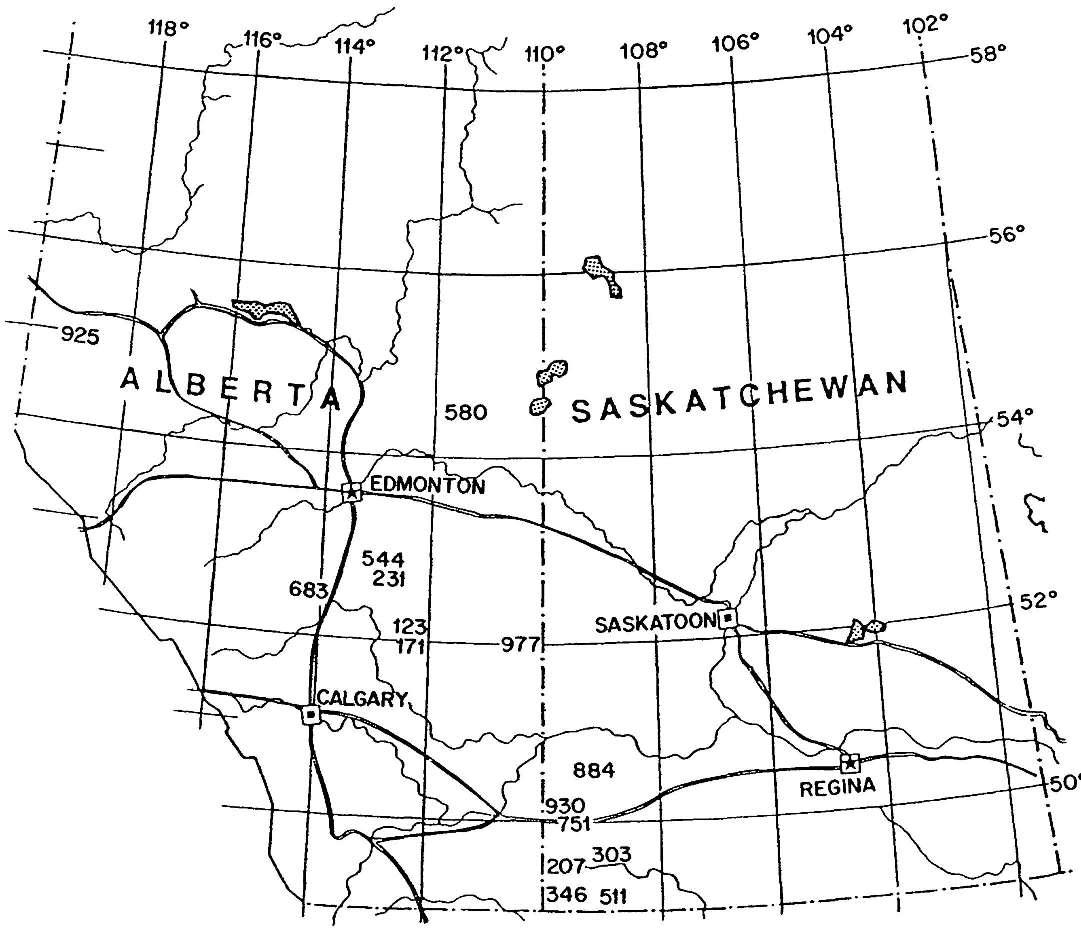

FIG. 1—Locations of the 15 MORP event areas visited from 1985–1991 listed in chronological order of investigation date. Original map from HBG 89. The numbers are MORP catalogue numbers.

925 – Grande Prairie	231 – Meeting Creek	303 – Edgell
123 – Byemoor	977 – Altario	346 – Consul
171 – Endiang	930 – Golden Prairie	207 – Cypress Hills
683 – Lacombe	884 – Great Sand Hills	751 – Maple Creek
544 – Edberg	511 – Claydon	580 – Fork Lake

A common occurrence noted in almost every area was a local rock collector. Such residents are invaluable as guides to the types of local surface rocks and as a potential home for any meteorites found in the area.

Conclusions. While efforts to date have not produced a new MORP meteorite recovery, the field effort has produced a useful database from which to gauge the fall regions where future efforts would be most justified based on ground conditions.

Offsetting the probable large mass of the Grande Prairie object is the unfavourable nature of the fall area, which consists mostly of forest. Sloughs and bogs are common in the area, but land clearing operations in the region provide some hope for a future recovery.

A dearth of trees in the Byemoor area is balanced by a high concentration of surface rocks. However, the appreciable size of this meteorite may make it a conspicuous feature upon the short grass prairie. Nearby Endiang is in very similar terrain, but the probable smaller dimensions of the meteorite which fell there reduce the chances of recovering it.

Any material which may have survived the Lacombe fireball may be easy to locate, provided it avoided those localized areas fraught with surface rocks or carpeted with chapparals.

The area around Edberg continues to be promising because of the probable large size of the terminal mass and the numerous pasture areas throughout the likely fall ellipse.

Meeting Creek's prospects are not as good because of the probable small terminal mass of the fireball, poor terrain, and high rock concentrations. Similar problems occur for Altario and Consul to a lesser degree, and Claydon to a much greater degree.

Fork Lake was one of the largest events observed with the MORP network, but the area of fall is largely wooded. High rock concentrations, rough terrain and a very large fall ellipse make recovery problematic.

Golden Prairie may be worthy of follow-up hunts. If the dunes in the area are stable, and most of the pasture is as rock-free as the small area sampled, the relatively large terminal mass makes for an attractive combination. Shifting dunes, on the other hand, might make recovery of a new meteorite more difficult.

The Great Sand Hills fall is certainly one of the better candidates for future hunts. The extreme lack of surface rocks would make identification easy. The short grass and numerous flat fields provide fruitful terrain for meteorite hunting. The terminal mass is also considerable, making fall location somewhat more favourable.

Edgell might be worth a follow-up hunt providing the rock pastures are more rock-free than the farmers in the area say. Age, inaccessibility, small terminal mass, and probable high rock concentrations work strongly against future recovery prospects.

The Cypress Hills fall is one of the most promising for future work, if not the most promising of all falls covered in the effort. High terminal mass, unworked open pasture, and a precisely determined fall point favour recovery. The surface rocks in the area are not a strong deterrent to a well-planned hunt.

Another good candidate for recovery is Maple Creek. Exceptionally good end point determination and a large pasture land to the south of the impact point promote recovery. The rocky field to the north is useless for our purposes unless

TABLE I
COLLECTED FIELD OBSERVATIONS AND DATA FOR 15 MORP EVENTS

Fall Name (No.)	Location	Mass (kg)	Fell	Date(s)	Area of Investigation	No. Farmers
Grande Prairie (925)	54 56′ N 119 11 W	12	1984 Feb 23 02 06 UT	1985 Apr 5 1985 Apr 6	54 56′–54 59′ N 119 00–119 16 W	15(4)
Byemoor (123)	51 57 N 112 20 W	0.74	1974 Aug 12 06 58 UT	1989 May 4	51 55–51 58 N 112 19–112 23 W	12(9)
Endiang (171)	51 54 N 112 13 W	0.16	1975 Apr 2 06 45 UT	1989 May 5	51 52–51 55 N 112 11–112 17 W	9(5)
Lacombe (683)	52 29 N 113 49 W	0.23	1981 Jul 6 09 00 UT	1989 Aug 12	52 29–52 30 N 113 48–113 52 W	25(11)
Edberg (544)	52 45 N 112 47 W	5.9	1980 Feb 4 09 14 UT	1989 Sep 10 1989 Sep 23 1990 Apr 21 1990 May 6 1990 Sep 8 1991 Jun 6	52 43–52 46 N 112 44–112 51 W	24(11)
Meeting Creek (231)	52 42 N 112 39 W	0.18	1976 Feb 4 04 52 UT	1990 May 6	52 40–52 46 N 112 37–112 41 W	13(9)
Altario (977)	51 54 N 110 11 W	0.16	1984 Nov 20 05 51 UT	1990 Jul 20	51 50–51 55 N 110 10–110 13 W	6(5)

TABLE I (*concluded*)

Fall Name (No.)	Location	Mass (kg)	Fell	Date(s)	Area of Investigation	No. Farmers
Golden Prairie (930)	50 10′ N 109 39 W	0.52	1984 Feb 8 08 57 UT	1990 Jul 22	50 07′–50 15′ N 109 25–109 40 W	6(3)
Great Sand Hills (884)	50 33 N 109 04 W	0.36	1983 Aug 29 04 17 UT	1990 Jul 23	50 32–50 34 N 109 02–109 05 W	1(1)
Claydon (511)	49 10 N 108 52 W	0.15	1979 Nov 20 02 06 UT	1990 Jul 25	49 07–49 12 N 108 50–108 53 W	4(2)
Edgell (303)	49 40 N 108 58 W	0.11	1977 Apr 15 10 37 UT	1990 Jul 25	49 39–49 42 N 108 55–109 00 W	4(2)
Consul (346)	49 17 N 109 32 W	0.12	1977 Nov 22 05 01 UT	1990 Jul 26	49 16–49 18 N 109 30–109 34 W	3(2)
Cypress Hills (207)	49 35 N 109 33 W	0.56	1975 Nov 16 06 58 UT	1990 Jul 26	49 34–49 36 N 109 30–109 38 W	1(1)
Maple Creek (751)	50 01 N 109 19 W	0.28	1981 Nov 23 04 25 UT	1990 Jul 27	50 00–50 04 N 109 16–109 22 W	2(1)
Fork Lake (580)	54 26 N 111 38 W	11	1980 Sep 1 08 10 UT	1991 Sep 6 1991 Sep 7	54 24–54 30 N 111 32–111 55 W	44(16)

TABLE II
FURTHER DATA ON 15 MORP EVENTS

Fall No.	Terrain	Field work	Surface rock density
925	Dense, mostly deciduous forest with patches of open farm land.	70 person-hours of footsearching in open farm fields north of impact point.	Moderate
123	Typical prairie with grassland and small rolling hills; many dry sloughs and rocks.	None.	Very high
171	Typical prairie with grassland and small rolling hills; many dry sloughs and rocks.	Searched through a local rock collection.	Very high
683	Small rolling hills; widely cultivated; 15% of area forested; no sloughs.	Footsearch along fenceline near impact point; one rockpile searched.	Moderate
544	Gently rolling to almost flat prairie; about 10% of the area is forested; soil is black and ploughed to 20 cm; some large sloughs close to the impact point, though region is generally dry.	41 person-hours footsearching in open fields north and west of impact point, covering 0.2 km^2; 10 rockpiles searched.	Moderate
231	Gently rolling to almost flat prairie; 10% forested; short prairie grass common.	Brief footsearch near impact point amounting to 2 person-hours.	Moderate
977	Flat prairie with some knolls; many sloughs with scrub in lower areas.	Brief footsearch near impact point; two rockpiles searched.	Moderate

TABLE II (*concluded*)

Fall No.	Terrain	Field work	Surface rock density
930	Flat dry prairie with blowouts; patches of scrub and forest; no sloughs.	None.	Low
884	Semiarid with sparse short grass; many sand dunes; 30% forested; no rocks.	15 person-hours footsearching covering 0.3 km^2; no rocks encountered.	Very low
511	Flat with no trees or scrub; heavily cultivated region; many rocks.	2 rockpiles searched near impact point.	Very high
303	Pastureland in rolling countryside; many surface rocks.	None.	High
346	Flat with light coloured soil; many rocks in heavily cultivated fields.	None.	Low
207	Pastureland in rolling countryside; small trees and scrub in low areas.	Brief footsearch near impact point.	Moderate
751	Flat with dark soil; some sloughs with accompanying scrub and small trees.	8 person-hours footsearching south of impact point covering 0.1 km^2.	Moderate
580	Equal areas of pastureland and forest; generally flat.	2 person-hours footsearching northwest of impact point.	High

FIG. 2—This pseudo-meteorite was found in the Fork Lake area. The outer black crust was formed during land clearing operations in that area involving burning.

the farmer ploughs up the specimen and recognizes it. Rock concentrations seem no higher than at Cypress Hills, so a follow-up search in the pasture of interest could be fruitful.

The experience gained from field work conducted while trying to recover MORP meteorite falls has given the authors some limited insight into what would constitute the basis for a recoverable meteorite.

High terminal mass is an obvious factor aiding recovery, while forested areas all but preclude hope for recovery. Open fields do not automatically mean good hunting conditions, as cultivated fields are usually rock covered because of mixing to depths of 10–15 cm. Large numbers of surface rocks quickly demoralize the most ambitious searchers. Even fields not suffering from this handicap (such fields being rare indeed) still may not be conducive to meteorite hunting, such as when unmoved surface rocks accumulate a covering of lichen over time. The lichen we have seen is often black in colour reminiscent of a meteorite fusion crust and hence confusing for searchers. Also, we have noted that areas experiencing land-clearing followed by burning may contain charred surface rocks which look very much like meteorites (example figure 2).

It should be noted that the one successful MORP meteorite recovery took place in winter, shortly after the fall when the dark mass contrasted with the white surface. Perhaps the best possibility for meteorite recovery in the Canadian prairies would be in winter shortly after a meteorite fall, and not during a delayed search in summer.

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