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A. A. Ruitenberg, J. Chandra and D. S. Secord

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Article abstract

Large amounts of geologic field data have been produced as a result of recent geologic investigations by the New Brunswick Department of Natural Resources, financed by the Federal Department of Regional Economic Expansion. This necessitated designing a standardized system for the collection, storage and retrieval of geologic field data, which is briefly described in this report.

Collection, Storage and Retrieval of Geological Field Data in Precambrian and Paleozoic Rocks of Southern New Brunswick

A. A. Ruitenberg, J. Chandra
and D. S. Secord
Department of Natural Resources
Mineral Resources Branch, N.B.
P.O. Box 1519, Sussex, N.B.

Summary
Large amounts of geologic field data have been produced as a result of recent geologic investigations by the New Brunswick Department of Natural Resources, financed by the Federal Department of Regional Economic Expansion. This necessitated designing a standardized system for the collection, storage and retrieval of geologic field data, which is briefly described in this report.

Introduction
Vast amounts of geologic data produced as a result of recent geologic investigations by the New Brunswick Department of Natural Resources necessitated the use of a standardized system for data collection adapted to computer processing. This system was designed to: 1) insure collection of all pertinent field data, 2) reduce subjectivity in observations and recording, 3) improve efficiency of data processing.

Our system can incorporate typical lithologic and structural data of deformed Precambrian and Early Paleozoic metasedimentary, volcanic and intrusive rocks in New Brunswick. We suggest, moreover, that our method can be applied, with possible minor modifications, to tectonites in other parts of the northern Appalachians.

Other systems for computer storage and retrieval of geologic field data have been developed for regional surveys in Manitoba (Haugh *et al.*, 1967), British Columbia (Hutchison and Rodderick, 1968) and Quebec (Wynne-Edwards *et al.*, 1970). These systems were not amenable for typical field data in the northern Appalachians of New Brunswick.

Our field data have been collected in a standardized format (Fig. 1). Common lithologic and structural data as well as standard reference information were recorded in coded form (Table I). Other pertinent data were incorporated in additional notes. Emphasis was placed on structural data because most rocks in the area have been subjected to intense polyphase deformation. The field sheet has been designed for easy transfer to I.B.M. punch cards for retrieval and processing. Our present system has been used successfully for four years. We hope that the following description of our method will be helpful to other geologists working in the northern Appalachians.

The senior author designed the data and code sheets with assistance of D. S. Secord, S. M. Buttimer, B. Jones and D. V. Venugopal. The computer program was written by D. S. Secord and it was partly modified and tested in detail by J. Chandra, as shown in this report. Professor David Bonyon of Acadia University assisted by converting his general purpose computer program to produce stereo net diagrams (Bonyon and Stevens, 1970) for punched output of our structural data.

Description of Data Sheet
This standard data sheet (Fig. 1) is divided into four sections: 1) Location and general reference, 2) Lithologic descriptions, 3) Structure, and 4) Description of sample data, formational names, geologic age and available additional data.

Location and General Reference Section. Outcrops with fundamental lithologic and structural data have been plotted on base maps

	Code	Explanation
Lithology	RT	Rhyolite Tuff
	ST	Sandstone
	SS	Siltstone
	DB	Diabase
	GT	Granite
Colour and Value	MR,T	Maroon, Mottled
	MR,M	Maroon, Medium
	GG,M	Grey-green, Medium
	GN,D	Green, dark
Further description	B	Interbedded
	K	Dyke
	I	Intrusive
Grain Size	M	Medium (1-5 mm)
	F	Fine (0.1-1 mm)
	V	Very Fine (0.1 mm)
Texture (Primary)	19	Porphyroclastic
	09	Moderately sorted
	08	Well sorted
	04	Porphyritic
	01	Granular
Texture (deformation)	1	Cataclastic
Minerals and/or Rock Types	VF	Volcanic Fragments
	QZ	Quartz
	MX	Matrix
	MC	Mafics (undifferentiated)
	FU	Feldspar (undifferentiated)
	FP	Plagioclase
	FK	Potash Feldspar
	QT	Quartzite
	RL	Rhyolite
Alteration	C	Chlorite
	E	Epidote
Metallization	HD	Hematite, desseminated
	HV	Hematite, vein
	PD	Pyrite, disseminated
Cleavage or Schistosity	A	Slaty cleavage
	C	Crenulation cleavage
	B	Fracture cleavage
Veins	A	Metallized
Sills or Dykes	A	Diabase
Bedding Tops	K	Unknown
	U	Up
Faults	D	Dextral
Joints	S	Slip
	U	Unclassified
	E	Extension
Linear Structure	01	Intersection bedding (S_0) and first cleavage (S_1)
	04	Intersection first cleavage (S_1) and second cleavage (S_2)
	06	Intersection second cleavage (S_2) and third cleavage (S_3)
Minor Folds	3	Asymmetrical (S-shaped)
	1	Symmetrical
	2	Asymmetrical (Z - shaped)
Fold Group	1	Close to isoclinal folds with penetrative axial plane cleavage
	2	Open to tight folds which have deformed bedding (S_0) and cleavage (S_1)
	3	Chevron folds which have deformed structures of Group 1 and 2

Table I
Codes used in Figure 1.

MINERAL RESOURCES BRANCH, SOUTHERN NEW BRUNSWICK

Card No 0 Field Map No P28 o/c No B027 : Card No, Field Map No, o/c No appear in the first 8 columns of each card

Air Photo No 514-0214 Geologist RPM Date 280771 Project No 9315

o/c Location Longitude 654840 Latitude 452207 o/c Dimensions Length 0030 Width 0020

o/c Orientation 030 Correlative Field Map No Q27 o/c No 0014 *END CARD 0*

LITHOLOGY *CARD 1*

Rock Type	RT	ST	SN	DB	GT
Percentage	10	30	40	05	15
Colour & Value	MR T	MR M	GG M	GN D	GG M
Further Description	B	B	B	K	I
Grain Size	M	F	V	F	M
Texture Prim & Metam	19	09	08	04	01
END CARD 1 Deformation	1	1	1		1
Minerals & Percent	VF 4	QZ 5		FP 2	MU 2
And/Or	FU 1	QT 4		MX 8	FK 2
Rock Types & Percent	MX 4	RL 1			FP 4
(If Detrital)	QZ 1				QZ 2
END CARD 2					
Alteration Product					C
					E
Metalization & Description	HD	HV		FD	

NOTES

CARD 8 Subject Code G
THE G
RANITE IS
INTRUDED B
Y THE DIAB
ASE. THE RH
YØLITE TUF
F HAS A WE
AK EU *END CARD 8*

CARD 9 TAXITIC
FØLIATIØN
WHICH HAS
BEEN RECØ
RDED UNDER
FLØW STRU
CTURE.
END CARD 9

PLANAR STRUCTURE

	BEDDING	LAMINATION	FLOW STR	CLEAVAGE or SCHISTOSITY			BANDING or GNEISSOSITY		VEINS	SILLS or DYKES	
END CD 3 Info	1	1	1	A	C	B			A	A	
Strike	013	049	139	032	112	134			175	132	
END CD 4 Dip	60S	40N	47S	71N	80S	30N			80S	88S	
Rel Age				1	2	3			1	1	
Tops	U	K	K								

FAULTS

Info	1	1
Strike	085	178
Dip	20S	50N
Rel Age	1	2
Str Pch	075	80N
END CD 5 Sense	D	D

LINEAR STRUCTURE *CONT CD 6*

Type	01	04	06
Azimuth	130	270	020
END CD 6 Plunge	58	67	28

MINOR FOLDS *CARD 7*

Symmetry	3	1	2
Closure	3	1	2
Axial Plane Strike	112	032	134
Axial Plane Dip	80S	71N	30N
Axis Azimuth	281	026	114
Axis Plunge	50	18	10
Group	1	2	3

JOINTS *CARD 6*

Type	S	U	E		
Strike	140	114	050		
Dip	88S	24S	75N		
Intensity	04	05	10		

CONT CD 7 Grab Sample 1 Oriented Sample 1 Mineralized Sample 1 Chip Sample Fossil 1 Chemical Analysis Bulk Specific 1 Thin Section 1

Polished Section Photo 1 Formation Name CB Age PC Additional Data 1 *END CARD 7*

Figure 1
Field Data Sheet.

(scale one inch equals one quarter mile), which are designated by a letter and two-digits (card 0 – columns 2-4). Outcrops have been identified by a letter code assigned to each geologist (column 5) and a number (columns 6-8). Outcrop locations are determined on air photos which are designated by flight and photo numbers respectively, (columns 9-16). The name of the geologist, date and project number are indicated in columns 17-29. The following sections describe the outcrop location by longitude and latitude (columns 30-41), the dimension, and orientation (columns 42-52). A possible correlation of the lithologies comprising the outcrop with a standard section (columns 53-59) is indicated if the relationship is known.

Lithology. The upper part of this section (card 1) makes provision for recording five lithologies (columns 9-18), relative amounts of each (columns 19-28), colour (columns 29-43), contact relationships between various lithologies (columns 44-48), grain size (49-53) and texture (54-63). Presence of deformational effects is indicated by placing the number "1" in the appropriate column (64-68).

The central part of this section indicates the relative amounts of minerals and rock fragments for various rock types (card 2 – columns 9-80 and card 3 – columns 9-11). The lower part of this section (card 3) indicates rock alteration (columns 12-26), metallic minerals and mode of occurrence (columns 27-56). Additional information about these are usually given in the notes (cards 8 and 9).

Structure. This section is divided into two parts: a) Planar structures and b) Linear structures.

In the sub-section on planar structures, the blocks near the top of each column (card 3 – columns 57-67) indicate the presence (referred to by the number "1") and/or nature (indicated by a letter) of various types of planar structures. Below these, provision has been made to indicate strike (card 4 – columns 9-41), dip angles and directions (columns 42-74) and relative ages of various structures which are indicated by numbers (card 5 – columns 12-19). Faults are recorded in a similar fashion (card 5 – columns 20-35), but, in addition, pitches of striations and sense of movement are indicated (columns 36-43). Joints have been classified into three categories (Fig. 2) and provision has been made for five sets (Fig. 1). In addition to attitudes (card 6 – columns 9-43), the intensity has been indicated in joints per meter (columns 44-53).

Linear structures (Fig. 2 shows a classification of intersection and mineral lineations) are recorded on card 6 – columns 54-74. The geometry (card 7 – columns 9-14) and attitudes (columns 15-47) of folds have been indicated in the next section. Allowance has been made for three groups of folds which can usually be recognized in most polydeformed rocks of the region (columns 48-50). At any particular locale, effects of all types of deformation may not be present, and therefore, where evidence of sequence is lacking the folds have been classified on the basis of style alone.

The remainder of card 7 describes various types of samples collected (columns 51-55), sample preparations (columns 56-60), formational name (columns 61-62), age (columns 63-64) and presence of additional data is indicated in column 65. Cards 8 and 9 are entirely used for additional field notes.

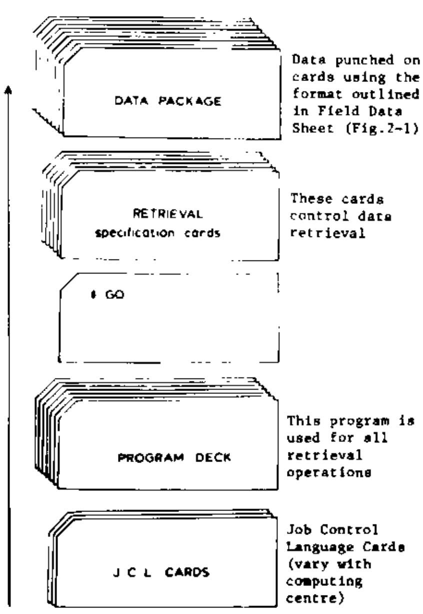

Figure 2
Typical Retrieval Operation Deck.

Data Retrieval

A computer program has been written to store and retrieve geologic and related data. Print out of data is designed to facilitate comparison and manipulation. The following flow chart illustrates the sequence of punched cards in a typical retrieving operation (Fig. 2).

The main program is capable of both full print out or retrieval of part of the data. Figure 3 shows the specification cards in sequence for retrieval purposes.

Acronyms used to construct word codes for the required specifications are described in the following pages.

Description of Retrieval Specification Cards

The retrieval specification card (R.S. Card 1) following the $GO card shows:

1) Type of data required, 2) Location parameter, 3) Lithological parameter, 4) Type of output required for structural data (punch out or print out).

Retrieval specification Card 1 (R.S. Card 1) is shown in Figure 4.

Some examples of the use of R.S. Card 1 are:

a) STRU, COBO, ROTY, POPL.
Punched output of planar structures (POPL) is required for a rock type (ROTY) (ROTY specified on R.S. Card 4) within certain co-ordinate boundaries (COBO) (COBO specified in R.S. Card 3).

b) NOTE, PACK, ROTY
Printed output is required for all notes (NOTE) on a particular rock type (ROTY) in the entire data package (PACK). The rock type is specified in R.S. Card 4.

Some examples of R.S. Card 2 are:

a) PLST, CLSC, 3, A, C, B.
Three types (3, A, C, B) of cleavages (CLSC) are requested under planar structures (PLST). When types are specified by only one letter or one number, the type symbols are placed in columns 13, 16, and 19 (See Figure 5). Print out will be generated even though one of these types is present.

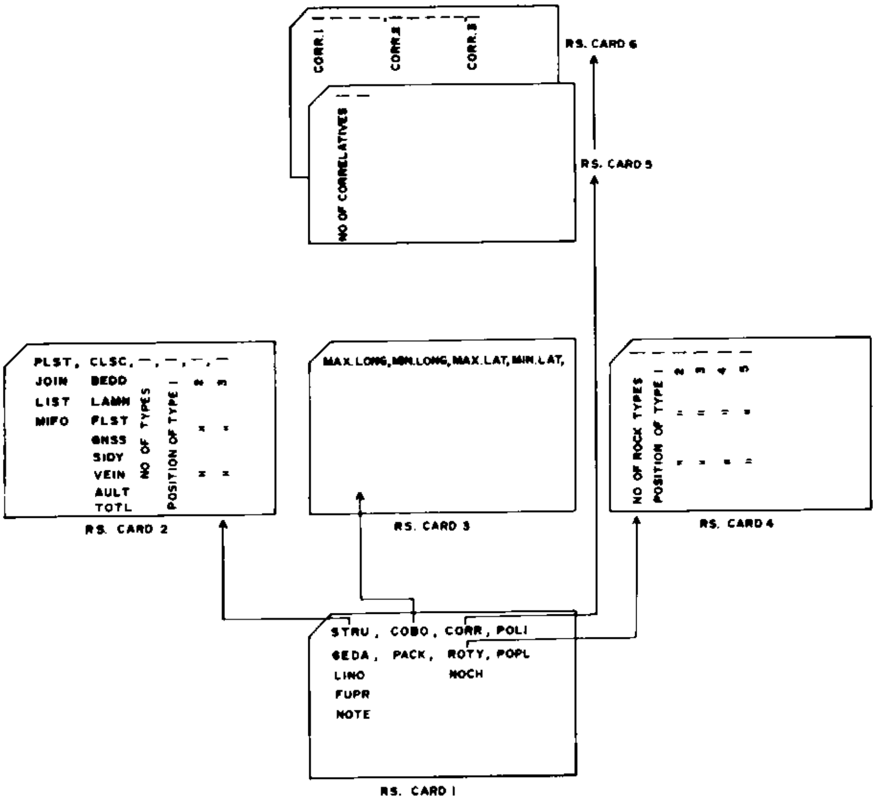

Figure 3
Retrieval Specification Cards.

TYPE OF OUTPUT	CODE	LOCATION PARAM	CODE	LITHOLOGICAL PARAM.	CODE	OUTPUT OPTION (Structure)	CODE
FULL PRINTOUT	FUPR	Coordinate boundaries	COBO	Rock type (S)	ROTY	Punched output for planar structure	POPL
GENERAL DATA	GEDA	Package (data package)	PACK	Correlative (S)	CORR	Punched output for linear structure	POLI
LITHOLOGY AND NOTES	LINO			No check required	NOCH		
STRUCTURES	STRU					Result in printout of data	(blank)
NOTES	NOTE						

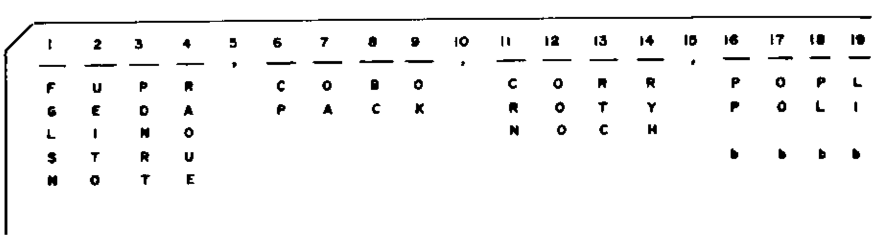

Figure 4
Retrieval Specification Card 1.
(b = blank space).

b) LIST, TOTL, 3, 01, 04, 06
A total (TOTL) check is requested for three types (3, 01, 04, 06) of linear structures (LIST).

c) MIFO, TOTL, 3, 1, 2, 3
A total (TOTL) check is made for three types (3, 1, 2, 3) of minor folds (MIFO).

The use of R.S. Card 3 is shown in Figure 6. The code COBO, representing co-ordinate boundaries, restricts the computer to a part of the data deck within certain geographic boundaries indicated by maximum and minimum latitudes and longitudes. The computer can also be requested to read through the entire data package by using the acronym PACK in R.S. Card 1. In this case, the use of a COBO specification card (R.S. Card 3) is unnecessary.

Figure 7 illustrates the use of R.S. Card 4 which specifies only rock types (ROTL). When no check is required for any particular rock type the acronym NOCH is used in R.S. Card 1. This eliminates the use of card 4 as shown in Figure 4.

In order to specify correlatives (CORR), R.S. Card 5 and R.S. Card 6 (Figure 8) are used in place of R.S. Card 4. A maximum of 10 correlatives may be specified.

Examples of Retrieval Operations

Data from the Field Sheet (Fig. 1) was used to generate these results. The examples (Table II) show the sequence of retrieval specification cards and the printed/punched result.

Conclusions

Our computer oriented method of geologic data collection, storage and retrieval has the following advantages over conventional methods:

1) It provides for accurate collection of all pertinent geologic field data.
2) Subjectivity of standard geologic observations is greatly reduced, while provision for additional notes and sketches allows for sufficient flexibility of the system.
3) Training of new geologists and senior students has been greatly accelerated as a result of this system.
4) Editing and correlation of geologic data collected by large numbers of observers is greatly facilitated.
5) Punched output of various types of geologic data can be produced rapidly for any part of the area or specified geologic parameter. This greatly accelerates final processing of structural and lithologic data.
6) Mineral exploration geologists can rapidly search our data file for mineral occurrences, alteration zones, rock assemblages and structures favorable for deposition of metallic minerals.

STRUCTURAL CATEGORY	CODE	QUALIFIER	CODE
Joints	JOIN	Total	TOTL
Linear 3tructure	LIST	Total	TOTL
Minor folds	MIFO	Total	TOTL
Planar structure	PLST	Bedding	BEDD
		Lamination	LAMN
		Flow structure	FLST
		Cleavage or schistosity	CLSC
		Banding or gneissosity	GUSS
		Sills or dykes	SIDY
		Veins	VEIN
		Faults	AULT

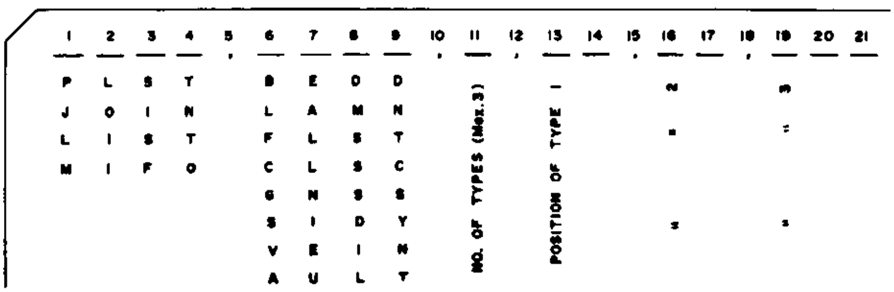

Figure 5
Retrieval Specification Card 2.

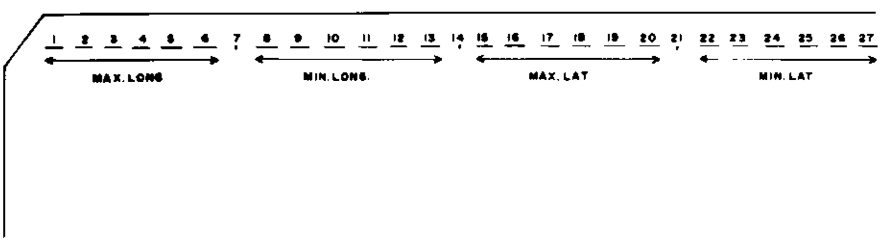

Figure 6
Retrieval Specification Card 3 (COBO).

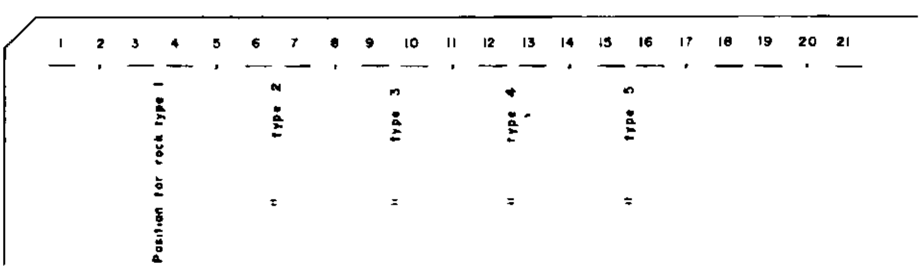

Figure 7
Retrieval Specification Card 4 (ROTY).

Acknowledgements
Design of our system was financed with funds provided by the Federal Department of Regional Economic Expansion. Co-operation of Dr. D. Bobyon in modifying his computer program for the production of stereo-net diagrams, is greatly appreciated.

Note. A copy of the computer program and complete code sheet can be obtained from the authors.

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MS received, June 5;
revised June 14, 1974.

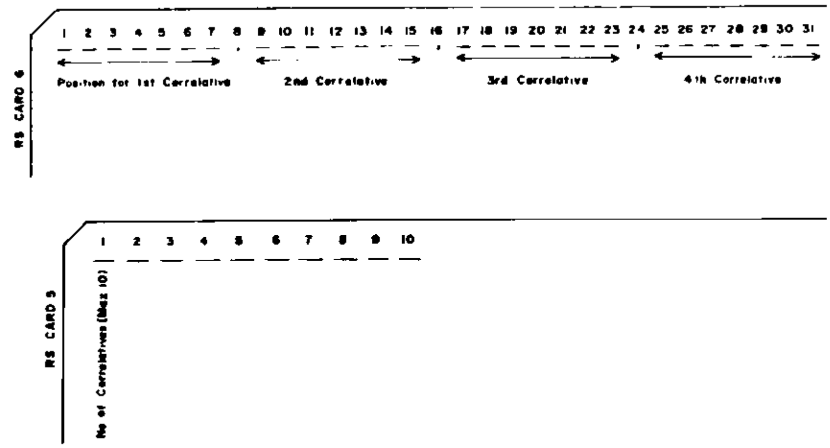

Figure 8
Retrieval Specification Card 5 and 6 (CORR).

Table II

EXAMPLE 1

No. of RS Cards Required LINO,PACK,NOCH
1

O/C NO P28B027 LONG 654840 LAT 452207

LITHOLOGY

ROCK TYPE	RT	ST	SN	DB	GT
PCT	10	30	40	5	15
COLOUR	MRT	MRM	GGM	GND	GGM
FURTHER DESCR	B	B	B	K	I
GRAIN SIZE	M	F	V	F	M
TEXTURE PRIM	19	09	08	04	01
TEXTURE DEFOR	1	1	1		1
MINERAL PCT	VF4	Q25		FP2	MU2
AND/OR	FU1	QT4		MX8	FK2
ROCK TYPE PCT	MX4	RL1			FP4
IF DETRITAL	QZ1				QZ2
ALTERATION PR					
METALLIZATION AND DESCRIPTION	HD	HV		FD	

NOTES

G THE GRANITE IS INTRUDED BY THE DIABASE. THE RHYOLITE TUFF HAS A WEAK EUTAXITIC FOLIATION WHICH HAS BEEN RECORDED UNDER FLOW STRUCTURE

TERMINATION

EXAMPLE 2

No. of RS Cards Required Q270014
5
01
654845,654835,452230,452200
PLST,CLSC,2,A ,B
STRU,COBO,CORR

STRUC P LOC C NO 2 TYPE(S) A B
1
4
3
COORDINATE BOUNDARIES LONG 654845 654835 LAT 452230 452200
NO3 1 CORR(S) Q270014,
O/C NO P28B027 LONG 654840 LAT 452207
PLANAR STRUCTURE

	BED	LAM	FLS	CLE	OR	SCH	GNE	VE1	VE2	SI	OR	DY
INFO	1	1	1	A	C	B	0	0	A	A		
STRIKE	13	49	139	32	112	134	0	0	175	132		0
DIP	60S	40N	47S	71N	80S	30N			80S	835		
TOPS	U	K	K									
REL AGE				1	2	3	0	0	1	1	0	

	FA1	FA2
INFO	1	1
STRIKE	95	178
DIP	20S	50N
REL AGE	1	2
STRI PI	07S	80N
SENSE	D	D

TERMINATION