Curragh Resources Inc.

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February 21, 1990

**Dr. Ken McClay**
Memorial University of Newfoundland
Centre for Earth Resources Research
Department of Earth Sciences
St. John's, Newfoundland
A1B 3X5

Dear Ken:

**RE: VANGORDA RESEARCH PROJECT - DENNIS BROWN**

I have discussed the proposed research project, both within Curragh and with DIAND, particularly with Steve Morrison, Chief Geologist for DIAND. As I understand it, Steve is quite interested in having DIAND participate in the project but requires funding to be finalized. This would I presume, be dependent upon a renewed MDA Agreement between Canada and the Yukon. We of course, have no way of predicting whether that extension is going to come.

In the meantime, we are prepared to get the program on "go" by employing Dennis for the summer starting around or about June 1, 1990 (or earlier if desired). The employment would be for the summer field season, which I presume would extend through September. It would be as part of the exploration program in the district but would be focused around the Vangorda Deposit. We will be carrying out some drilling on Vangorda this Spring, however, I think that program will be finished by the beginning of June. There may be some relogging of core possible as there is a considerable amount of core from older drilling programs. Numerous surface exposures around Vangorda can be mapped and, during the summer period, we anticipate that the pit will be opened up, at least in the south-east part of the ore deposit, so there will be some pit mapping that could be done.

Furthermore, as we discussed in Vancouver the underground operation is underway at Faro and I think some mapping in the underground openings would be relevant. There will other aspects of the field program that Dennis could participate in although I think there will be enough to keep him busy between Vangorda and Faro underground.

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As far as your further involvement is concerned, we would welcome seeing you but we are trying to control costs rather closely these days. I understand that you are coming to Vancouver for a GAC meeting in May. If possible I think we could bring you up to Faro after that meeting to have a look at the underground and particularly the structural mapping that is going on to ensure that the appropriate data is being collected and of course to have enough time in the underground openings to get a good understanding of the structure. I anticipate that by May there will be considerably more exposure of sulphides than there was at Cirque. We have CMD doing a decline, as at Cirque, and there are no guarantees about progress however this job seems to have been going substantially better than Cirque. There are four faces open so that delays at one face do not necessarily influence the entire work.

Could you please get back to me with your availability in that sort of time frame. As well, could you let me know what other times you are expecting to be in Canada during the year. I think it would be appropriate to try and get up to the District later in the summer. Of course, as always, we have little idea as what is going to be happening at Cirque. It is clear however that further excavation will be within the ore body rather than in the footwall as we have found the footwall to be likely unsuitable for extensive excavations. This would suggest that your interest in the project may be considerably enhanced from the previous plan. I think we will just have to wait and see what happens on that project.

At any rate, I clearly recognize the benefits to Curragh of a good program of structural mapping in the Vangorda Pit. I believe it has potential payoffs in terms of enhanced grade control and predictability of ore. As you know I feel that the difference between the green schist deposits on the Vangorda Plateau and amphibolite Faro deposit needs to be recognized and that a new set of procedures need to be implemented for structural mapping. In general I expect structural mapping to be of more use on the Vangorda Plateau. However, there is a need to get a program started off on the right foot. Because of this interest we are prepared to start the program. However, I would also like to see the maximum additional funding from DIAND through an MDA Agreement or from whatever other sources are available because of the intrinsic

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scientific payoff to the geologic community as well as just Curragh. We will have to see what happens once Michael Wilson's budget comes down and all the bricks fall where they are going to fall in the next couple of months and finalize the program at that time.

Please get back to me with any response you believe is relevant; Dennis' reaction to this limited assurance for the coming year and the likelihood that the program will proceed to a full thesis research project.

Yours very truly,

**CURRAGH RESOURCES INC.**

Madeleine E. Beaudoin

for/ Gregg A. Jilson
Vice-President, Exploration

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Mr. Greg Jilson,
Vice President,
Exploration,
Curragh Resources,
117 Industrial Road,
Whitehorse,
Yukon.

Dr. Ken McClay,
17 - 1 - 90.

Dear Greg, VANGORDA RESEARCH PROJECT - DENNIS BROWN

Dennis is now anxious to follow up on this project and get some aspects sorted out. He has been offered a scholarship to do PhD research in New Zealand but this is not necessarily what he wants and therefore he is anxious to find out what is happening over the Vangorda project.

To date Dennis has applied for three scholarships that would essentially fund his living expenses for the PhD research based in the UK (with the possibility of spending some time also here at Memorial). He will also apply for a fourth scholarship in the summer. The results of these applications will not be known until late February and into mid-late March.

What we need to sort out are the following -

1. Summer employment with Curragh 1990. He needs to get this assured now or will need to start looking elsewhere as 1990 is likely to be tight for student jobs in the industry (no MDA work). If Curragh wish to follow up on this, a letter directly to him would be appropriate. Thanks.

2. We need to sort out the research programme should Curragh wish to go ahead with the project - I am assuming that they do. I enclose a proposed programme of research with the funding required. Obviously the best way of doing this is if Dennis obtains one of these scholarships which will pay living expenses and fees etc.. If this is the case then then following needs clarification -
a) Initial fieldwork in summer of 1990 - as above - employment in Curragh's exploration programme in the Anvil district that would allow Dennis to gain familiarity with the area and work on the Vangorda exposures and drill core.
b) Fieldwork in 1991- early summer onwards - mapping Vangorda Pit. Fieldwork expenses plus return airfare from the UK. Summer employment? 6 months? Expenses for supervision by Dr. K.McClay - return airfare plus field expenses (not consulting!).
c) Fieldwork 1992 - same arrangements as in 1991.

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3 Should Dennis *not* obtain a scholarship then an alternative funding strategy needs to be worked out at the levels shown in my accompanying document (note these levels do not apply if a scholarship is obtained as fees etc. will be covered by the scholarship). These alternatives could be -
a) Direct funding by Curragh at the levels shown in the accompanying document with a guarantee of at least two years support in that registration for the PhD degree can be assured.
b) Funding through DIAND and an MDA agreement - this looks doubtful and would I suspect, have to be channelled through CERR at Memorial to maintain the Canadian content. More difficult and less certain.

I realise that you as usual are hectically busy and so many find this difficult to deal with but I believe that we need to get some of it straightened away as Dennis needs to plan his future. He anticipates completing his MSc thesis by Xmas 1990 and would be ready to start the research programme early in 1991 - at a time when Vangorda comes on stream.

Let me know your thoughts.
Best wishes,

Dr. Ken McClay.

Encls.

**PhD RESEARCH STUDENTSHIP PROPOSAL TO:**

**CURRAGH RESOURCES, WHITEHORSE, YUKON**

# THE STRUCTURE AND GENESIS OF THE VANGORDA MASSIVE SULPHIDE DEPOSIT, ANVIL DISTRICT, YUKON.

**From:**

**Dr. K.R. McClay,**
**Department of Geology,**
**Royal Holloway and Bedford New College,**
**University of London,**
**Egham, Surrey, TW20 0EX,**
**England.**

# *THE STRUCTURE AND GENESIS OF THE VANGORDA MASSIVE SULPHIDE DEPOSIT, YUKON.*

## *Aims*

A three year PhD level research programme is proposed to investigate the structural evolution and genesis of the Vangorda Fe-Zn-Pb massive sulphide orebody, Anvil District, Yukon Territory.

The research programme will aim to -

1). Define the structural geometry of the orebody and the host rocks;
2). Determine the structural evolution of the deposit;
3). Define the distribution of ore types and ore mineralogy and their structural relationships and to develop predictive models for the structural control and distribution of the mineralisation;
4). Determine the nature of any alteration features and their relationships to structure;
5). Develop a genetic model for the Vangorda deposit - the origin and distribution of the sulphide mineralisation and the relationships to structure.

## *Background*

The Vangorda massive sulphide deposit occurs in complexly deformed Lower Palaeozoic meta-sediments of the Anvil District, Yukon. The deposit occurs as a complexly folded orebody of massive sulphides within polydeformed deformed quartz phyllites and graphitic phyllites. The structural relationships are only partially understood. Five phases of folding and faulting have been recognised with the dominant fabric being the $S_2$ foliation and with significant $F_3$ folding. The orebody has been deformed by both $D_2$ and $D_3$ deformations. Preliminary structural investigations point to significant southwesterly directed shearing in the plane of the deposit during $D_2$ deformation and also important folding during $D_3$ deformation.

The Vangorda deposit is an important base metal deposit about which little detail is known. A research programme is urgently needed to elucidate the structural geometry of the deposit for mine development and exploration for extensions to the known mineralisation, and to investigate the genesis of the deposit so that exploration models may be erected and tested elsewhere in the Anvil District. The opportunity exists during the life of the open pit operations to carry out detailed structural mapping of the orebody which would not only directly aid mining operations but would

also provide the data for a detailed research project.

## *Research Programme*

The research programme will involve detailed structural analysis, mineralogical, geochemical and isotopic investigations. The structural analysis will include detailed mapping of open pit development and structural logging of drill core. Particular attention will be paid to definition of structurally homogeneous sub-areas, zones of intense fabric and shear zone development, and to definition of $F_2$ and $F_3$ fold zones. This programme will be particularly relevant to determining the exact geometry of the orebody, determining the continuity and extent of deformation of the deposit and to interact with the mine development programme. Particular attention will be paid to the construction of cross-sections and the projection of structural data down-plunge. In addition detailed microstructural and fabric analyses will be carried out to analyse the effects of deformation and metamorphism on the ore assemblages. Three extended periods of fieldwork are envisaged for this project.

The studies of the genesis of the deposit will involve limited geochemical analyses of the mineralisation and host rocks, fluid inclusions and stable isotopic studies to determine the effects of metamorphism and deformation combined with collation of existing data sets. These studies will provide constraints on possible genetic models that can be applied to both local and regional exploration.

## *Timetable*

The research programme will run for three years - 1991 to 1994. It will involve extended periods of fieldwork at the Vangorda deposit with supervision by Dr. L.Pigage (Curragh Resources) and Dr. K.R. McClay (RHBNC). The research programme will be carried out in the department of Geology, Royal Holloway and Bedford New College, University of London and at the Department of Earth Sciences, Memorial University, St. Johns Newfoundland in cooperation with Dr. Tom Calon - (the time spent in each department by the research student will be dependent upon the scholarship/funding details).

## *Personnel*

The research student selected for this project is Mr. Dennis Brown, currently completing an MSc in structural geology at Memorial University. His curriculum vitae is enclosed with this proposal. The project will be supervised by Dr. K.R. McClay in conjunction with Dr. Tom Calon (Memorial) and Dr. Lee Pigage (Curragh Resources).

## *Resources Required*

### FINANCIAL

| | | | |
|---|---|---|---|
| **Year 1** | **1991-1992** | | |
| | **Personnel - PhD Student** | | |
| | PhD Student grant (NERC + £500.00) | | £6000.00 |
| | Tuition Fees | | £6500.00 |
| | Bench Fee | | £ 500.00 |
| | Sub-Total | | £13,000.00 |
| | **Travel and Expenses** | | |
| | Travel to Vangorda | | £1600.00 |
| | Conference attendances | | £ 300.00 |
| | Sub-Total | | £1900.00 |
| | **YEAR 1 TOTAL** | | **£14,900.00** |
| | In Canadian Dollars | Approximately - | $C 29,800.00 |

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The PhD student would spend one extended fieldwork period at Vangorda in the first year with one period of supervision (included in travel estimate above). It is anticipated that expenses in the Yukon would be found by Curragh Resources and that the student and supervisor would stay at the Anvil exploration camp.

**Year 2** **1992-1993**

**Personnel - PhD Student**

| | |
|---|---|
| PhD Student grant (NERC + £500.00) | £6480.00 |
| Tuition Fees | £7020.00 |
| Bench Fee | £ 500.00 |
| Sub-Total | £14,000.00 |

**Travel and Expenses**

| | |
|---|---|
| Travel to Vangorda | £1700.00 |
| Conference attendances | £ 300.00 |
| Sub-Total | £2,000.00 |

| | | |
|---|---|---|
| **YEAR 2 TOTAL** | | **£16,00.00** |
| In Canadian Dollars | Approximately | $C 32,000.00 |

In year 2 two periods of fieldwork would be undertaken at the Vangorda Mine with one period of supervision.

| | | |
|---|---|---|
| **Year 3** | **1993-1994** | |
| | **Personnel - PhD Student** | |
| | PhD Student grant (NERC + £500.00) | £7,000.00 |
| | Tuition Fees | £7,580.00 |
| | Bench Fee | £ 550.00 |
| | Sub-Total | £15,130.00 |
| | **Travel and Expenses** | |
| | Travel to Vangorda | £1,700.00 |
| | Conference attendances | £ 300.00 |
| | Sub-Total | £2,000.00 |
| | **YEAR 3 TOTAL** | **£17,130.00** |
| | In Canadian Dollars Approximately | $C34,260.00 |

In year three a final short field season would be undertaken if required.

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*Note. If a scholarship is obtained then the funding required will be substantially reduced - Curragh Resources would need to cover field expenses, supervision and bench fee expenses. In order to successfully attract the best possible student for this project it will be necessary to guarantee a minimum of two years funding in order that the candidate can satisfy the minimum registration requirements for a PhD. Mr. Dennis Brown has been identified as the best candidate for this research project.*

## *Liaison*

Close liaison will be maintained with Curragh Resources. It would be appropriate that a Dr. Lee Pigage at Faro/Whitehorse be a joint supervisor of the project in order to monitor the progress of the research. Annual reports on the research programme will be presented to Curragh Resources. Continuation of the project to years two and three will be contingent upon the student making satisfactory progress.

Curragh Resources will be provided with copies of the completed PhD thesis and with copies of all publications arising from this project.

## *Confidentiality*

During the course of this project (3 years) the results of this research programme will not be communicated to a third party (parties) without express permission of Curragh Resources. During tenure of the project publication can only be undertaken with full permission of Curragh Resources. Upon termination of the research grant it is anticipated that the results will be written up for open scientific publication.

## *Departmental Facilities*

The Geology Department at Royal Holloway and Bedford New College has all the field and laboratory equipment necessary for the successful completion of this project. Analytical equipment include microprobe, scanning electron microscopes equipped with EDAX analysers, fluid inclusion apparatus, INNA, 2 x XRDs, 2 x XRFs, 3 x ICPs and two new VG Isotopes Mass Spectrometers - for stable and radiogenic isotopes. In addition the Department has an extensive range of rock and mineral preparation equipment, in house computing, digitising and plotting equipment

## *Additional Information*

This research project will build upon the wide experience gained by Dr. McClay on the geology of massive sulphide deposits in deformed terrannes including - Mount Isa, Australia; Sullivan, J&L and Salmo Camp in SE British Columbia; Driftpile and Cirque deposits of NE British Columbia; Tom, Howards Pass and Faro deposits, Yukon Territory; Buchans deposit Newfoundland and the Black Angel deposit, Greenland.

## *Recent Publications by Dr. K.R. McClay*


1981. K.R. McClay and N.J. Price. Thrust and Nappe Tectonics. Spec. Publ. 9, Geol. Soc. London, 544pp.

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1987. K.R. McClay and P.G. Ellis. Geometries of extensional fault systems developed in model experiments. Geology, 15, 341 - 344.

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1987. K.R. McClay and P.G. Ellis. Analogue Models of Extensional Fault Geometries. In Coward, M.P., Dewey, J.F. and Hancock, P.L. (eds.), Continental Extensional Tectonics, Spec. Publ. Geol. Soc. London 28, 109 - 125.

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1987. M.G. Norton, K.R. McClay and N.A. Way. Tectonic Evolution of Devonian Basins of Northern Scotland and Southern Norway. Nor. geol. Tiddskr. 67, 323 -338.

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1990 P.G. Buchanan and K.R. McClay. Analogue models of inversion structures. Tectonophysics, EUG Symposium volume (in press)

1990 K.R. McClay. Deformation of stratiform, clastic hosted Zn-Pb (Barite) deposits in the northern Canadian Cordillera. Ore Geology Reviews (in press)