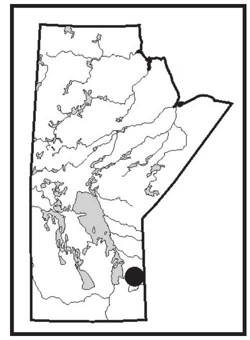
GS-16 Platinum group element dispersion patterns in humus samples of the Mayville Igneous Complex, southeastern Manitoba (NTS 52L12): survey results and interpretation

by P. Theyer



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Summary

Seven humus samples collected and analyzed in 2005 complemented the geochemical results from a series of 33 humus samples collected in 2004 in the area of the Mayville Igneous Complex. All samples were analyzed for Pt, Pd and Au to investigate their usefulness as pathfinders to Ni–Cu–platinum group element (PGE) sulphide mineralization that is known to occur in rocks underlying this area. Palladium's high mobility in aqueous surface environments contrasts with its ready adherence to organic matter, theoretically making it an ideal pathfinder element for areal surveys of sulphide-poor PGE prospects covered by swamps and glacial till (a common situation in the Canadian Shield).

The results of this survey suggest that this method has some applicability; however, geochemical responses over known mineralization are erratic and may be compromised by a number of uncontrolled and widely fluctuating variables inherent to this sampling environment. Such variables include, for instance, the length of time for which, and the volume of water to which, the humus sample was historically exposed; the composition of the sample; the thickness of the humus layer; the nature of the surrounding vegetation; and the possibly significant consequences that man-made disturbances such as logging operations have had on the humus profile and metal content.

Four Pd anomalies were identified in this survey, two of which were probably derived from known sulphide occurrences exposed in their vicinity. The remaining two anomalies are from unidentified sources. This survey, however, failed to identify a large Fe-Ni-Cu-PGE sulphide occurrence, underlying a substantial part of the investigated terrain, that was defined while the survey was in progress.

Introduction

The Mayville Igneous Complex (MIC), a mafic-ultramafic layered intrusion that is possibly part of the Bird River Sill (Trueman, 1980; Figure GS-16-1), has been explored for Ni, Cu, Cr and PGE for a number of years. Two Ni-Cu-PGE occurrences in this area, the Hititrite (Wright, 1932; Theyer, 1986) and the Mayville (Theyer, 1986, Figure GS-1-4), have been known for decades (Athayde, 1989).

Exploration for these commodities in the Mayville area historically relied on trenching and rock sampling of mineral occurrences; more recently on geophysical surveys followed by drilling; and, in the last few years, on areally extensive overburden stripping followed by channel sampling of the newly created exposures. The balance of the area is generally covered by a veneer of up to several metres of glacial till and swamps.

A detailed study of the behaviour and distribution patterns of Pd in aqueous surface environments (Wood et al., 1992; Wood, 2002), and its use as an exploration tool to define the location and distribution of PGE concentrations in the Lac des Isles area near Thunder Bay in Ontario (Hattori and Cameron, 2004), provided the inspiration and incentive to try this method in the Mayville area.

Geology and sulphide mineralization

The MIC in the northern part of the of the Bird River belt is an mafic-ultramafic body, at least 10 km long and 1.1 km thick, that intruded the contact of felsic-intermediate gneisses to the northand mafic-intermediate volcanic rocks of the Lamprey Falls Formation to the south. The exact extent of the intrusion is unknown, since both the upper and lower contacts are not exposed. Peck et al. (1999, 2002) subdivided the intrusion into an upper leucogabbroic-anorthositic zone and a lower, 200–300 m thick, heterolithic breccia zone. The heterolithic breccia zone is characterized by complexly interrelated angular and embayed anorthosite blocks, up to several metres thick, surrounded and in places invaded by pyroxenite, peridotite and chromitiferous peridotite. Sulphide mineralization is exposed in the heterolithic breccia zone.

The recently announced discovery of Fe-Ni-Cu-PGE–bearing sulphide mineralization associated with a 1.3 km long airborne magnetic-electromagnetic anomaly, the Mustang Minerals M2 zone (Mustang Minerals Corp., 2005), shows that the MIC contains not only disseminated Fe-Ni-Cu-PGE–bearing sulphides in the stratigraphically higher heterolithic breccia zone, but also at least one zone of massive Fe-Ni-Cu-PGE–bearing sulphides that is tens of metres wide by hundreds of metres long.

Humus samples

Hattori and Cameron (2004) emphasized that,

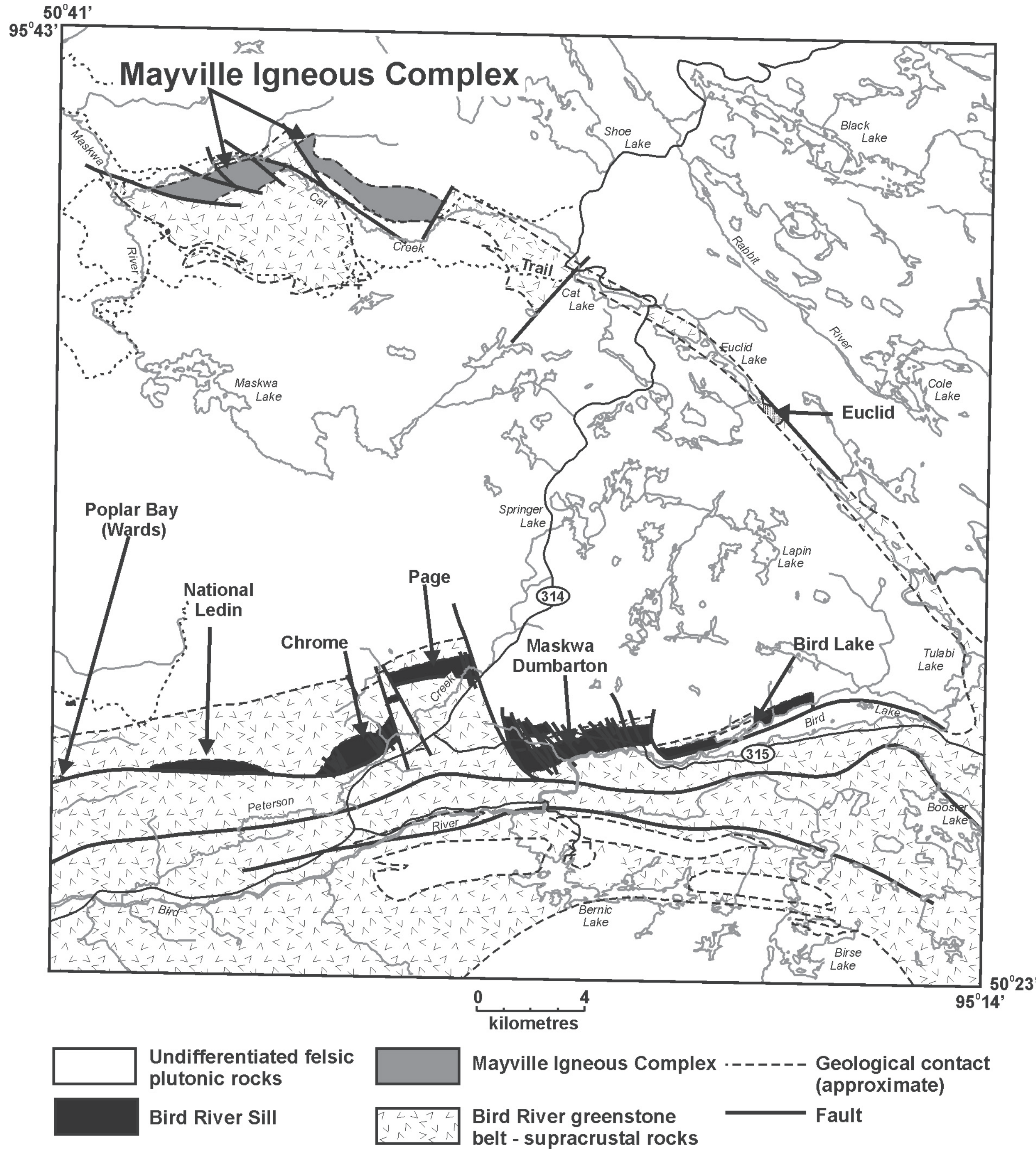

Figure GS-16-1: *Simplified geology of the Bird River greenstone belt, showing the location of the Bird River Sill and the Mayville Igneous Complex.*

owing to the high mobility of Pd in aqueous solutions, the effectiveness of a Pd-in-humus sample program is dependent on correctly sited sample locations, which in turn depend on a good understanding of the local topography and recognition of drainage patterns. Sample locations and numbers, the topography and inferred water drainage paths of the terrain underlain by the Mayville intrusion are depicted in Figure GS-16-2. The area is drained by two streams: Cat Creek, which meanders in a westerly direction near the northern edge of the map, and Maskwa Creek, a north-flowing subsidiary of Cat Creek at the western edge of the map. Drainage of the large waterlogged terrain south of Cat Creek is constrained by a prominent east-striking ridge, up to 30 m high, underlain by anorthosite and leucogabbro. The ridge is breached near its eastern end by a drainage channel in which sample 14 was taken.

Waterborne metals from the Mayville mineral occurrence and its surroundings are expected to drain into

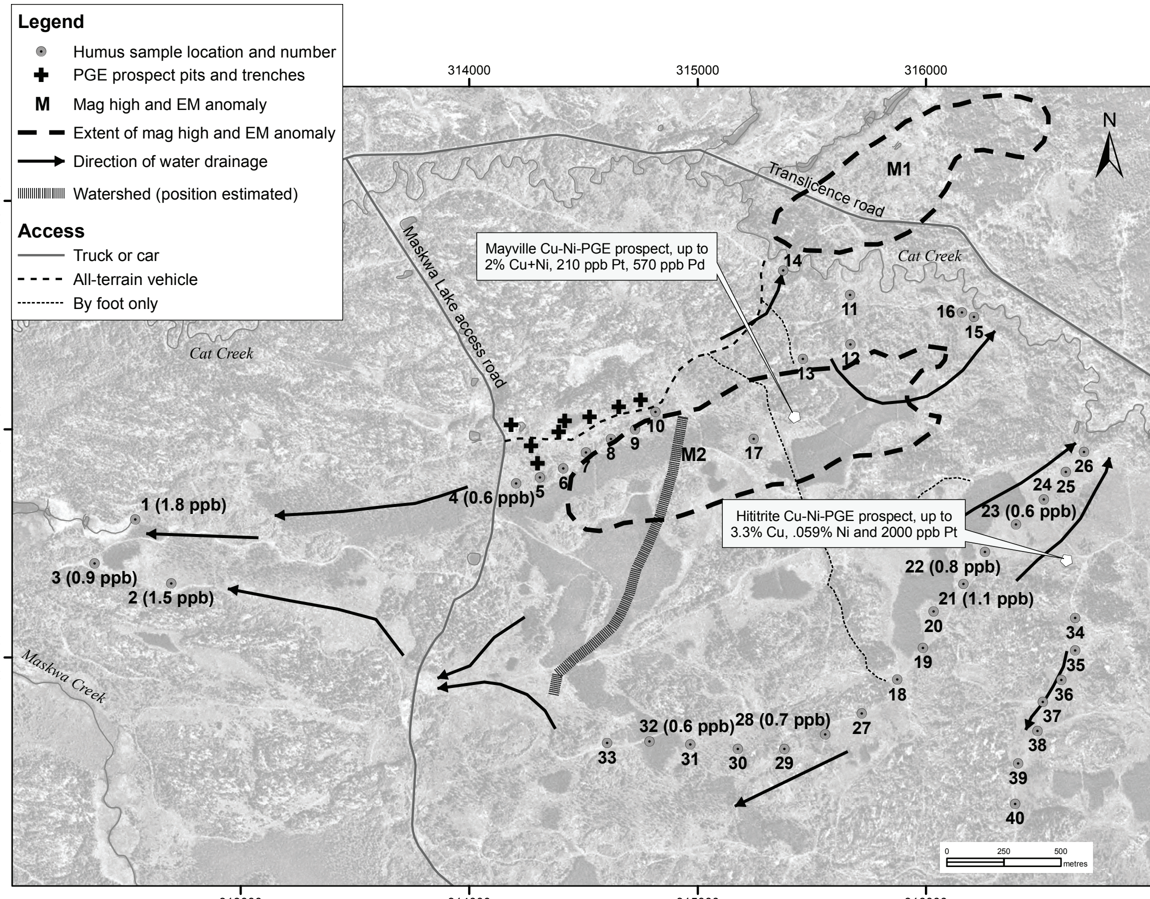

Figure GS-16-2: Topography, surficial-water flow patterns, access, and humus-sample locations and numbers, Mayville area. Abbreviations: EM, electromagnetic; mag, magnetic; PGE, platinum group element.

Cat Creek in the vicinity of samples 11, 12, 15 and 16. Samples 4, 5, 6, 7, 8, 9, and 10 were collected to further investigate the extent of the mineralization uncovered by Exploratus Ltd. Sample 17 was taken to combine the effect of the previous sample series. The sample series 18 to 33 and 34 to 40 were collected to detect the presence of any sulphide mineralization on the northwestern and southeastern sides, respectively, of the ridge that hosts the Hititrite Cu-PGE prospect. Samples 1, 2, and 3 were collected to detect potential PGE mineralization contained within the catchment area draining into Maskwa Creek (i.e., west of the watershed located in the area between the hill hosting the Hititrite mineral prospect and the ridge underlying the Maskwa Lake access road).

After air drying at room temperature, the humus samples were sieved to –80 mesh, a 15 g subsample was ashed, digested by aqua regia and analyzed using inductively coupled plasma–mass spectrometry (ICP-MS; Table GS-16-1). Detection limits of this method are 0.5 ppb Pt, 0.5 ppb Pd and 1 ppb Au.

Discussion

The aim of this study was to test the reliability and effectiveness of humus sampling as a tool to define and delineate the extent of PGE mineralization in an area underlain by a mafic-ultramafic intrusive body. This method relies, on one hand, on the high solubility of Pd in aqueous surface environments, which facilitates its widespread distribution, and, on the other hand, on the element's strong tendency to adhere to humus. Humus samples collected in or near drainage channels are thus expected to reflect Pd mineralization in the catchment area, thus providing explorationists with additional data as to the probable mineral potential of an investigated area.

The topography of the Mayville area is dominated by two subparallel east-striking ridges straddling a bog-filled valley that is up to 1 km wide by 7 km long. The northern ridge is underlain by anorthosite, whereas the southern ridge consists of gabbro and basalt. The valley, which is underlain by peridotite and gabbro, is characterized by a subtle topography perceptible only on satellite photogrammetry. A gently rising topographic high in the form of a north-northeast-striking ridge shape that is up to 5 metres higher than the surrounding terrain and effectively acts as a watershed, dividing the valley into eastern and western catchment and drainage basins. The existence

Table GS-16-1: Humus sample locations, physical environment and analytical results.

Sample no.	UTM (NAD 83) Northing	UTM (NAD 83) Easting	Pd (ppb)	Au (ppb)	Physio-graphy	Site description
1	5612105	312539	1.8	5	Fen	Very wet; edge of creek draining swamp; tamarack, sphagnum, bulrush, reeds, sedges
2	5611826	312697	1.5	4	Bog	Wet; sphagnum, birch, willow, blueberries sample collected from 10–30 cm depth
3	5611914	312360	0.9	3	Bog	Wet; aspen, pine, labrador tea 35 cm depth
4	5612264	314206	0.6	3	Bog	Wet; soggy grass, 30 cm thick waterlogged humus; stunted tamarack, pine, willow
5	5612298	314331	-0.5	2	Forest	Dry; 10 m south of pressure washed anorthosite exposure; well drained 3 cm thick humus layer
6	5612329	314412	0.6	3	Bog	Wet; tamarack, pine, willows, 30 cm thick humus layer
7	5612290	314310	0.6	3	Forest	Wet; spruce, willow, birch, aspen, sphagnum
8	5612399	314511	-0.5	2	Bog	Wet; 30 cm thick humus layer, aspen, willows
9	5612458	314620	0.6	3	Forest	Dry; aspens; 15 m W of trench; 20 cm thick humus layer
10	5612501	314727	-0.5	4	Forest	Dry; 3 cm thick humus layer overlying clay; minimal leaf litter
11	5612576	314816	-0.5	3	Forest	Well-drained 2 cm organics underlain by clay; bush willow, pine, aspen
12	5612873	315670	-0.5	4	Bog	Wet; willow, tamarack, pine, sedges, labrador tea
13	5612809	315460	0.5	2	Bog	Wet; willow, pine, sedges
14	5613195	315374	-0.5	3	Forest	Dry; pine, birch, aspen, willow, 7–8 cm thick humus overlying clay
15	5612991	316209	-0.5	2	Forest	Wet; birch, willow, tamarack, sedges, labrador tea
16	5613013	316157	-0.5	2	Bog	Wet;sphagnum, willows, tamarack, aspen
17	5612459	315245	0.6	3	Bog	Wet; aspen tamarack, willow, labrador tea, sphagnum
18	5611404	315874	0.6	2	Bog	Wet; tamarack, pine, willows, sedges, labrador tea, sphagnum
19	5611544	315986	-0.5	3	Bog	Wet; between escarpments 20 m south of mature spruce stand; labrador tea, sphagnum, sedges
20	5611701	316033	0.5	3	Bog	Wet; willow, pine, tamarack, labrador tea, sedges
21	5611823	316163	1.1	3	Bog	Wet; willow, aspen, black spruce, tamarack, labrador tea
22	5611963	316258	0.8	4	Bog	Wet; dense 5–10 yrs. Growth of willow, aspen, sphagnum, sedges
23	5612084	316392	0.6	4	Bog	Wet; ~20 years old pine, aspen, sphagnum, labrador tea, grass
24	5612192	316516	-0.5	5	Bog	Wet; ~20 years old pine, aspen, sphagnum, labrador tea, grass
25	5612313	316612	-0.5	3	Bog	Wet; recently logged (20 years) aspen and willows in clumps, labrador tea, sedges
26	5612401	316690	-0.5	4	Fen	Wet; at edge of creek draining into Cat Creek; bulrushes, reeds, willows, sedges
27	5611256	315718	-0.5	6	Bog	Wet; tamarack, spruce, labrador tea sphagnum
28	5611164	315558	0.7	2	Bog	Wet; edge of conifer forest, labrador tea, spagnum, sedges
29	5611102	315379	-0.5	3	Bog	Wet; recently logged, aspen, sphagnum, shrubs, outcrop 10 m west
30	5611102	315176	-0.5	3	Bog	Wet; tamarack, willow, labrador tea, sphagnum
31	5611121	314967	-0.5	4	Bog	Wet; willow thicket; labrador tea; sphagnum
32	5611133	314789	0.6	4	Bog	Wet; black spruce forest, labrador tea, sphagnum
33	5611127	314604	-0.5	15		
34	5611674	316653			Bog	Wet; willows, aspen, tamarack, sphagnum
35	5611531	316653			Bog	Wet; willows, aspen, tamarack, sphagnum
36	5611403	316592			Bog	Wet; sphagnum, sedges
37	5611307	316510			Bog	Wet; willows, aspen, tamarack, sphagnum
38	5611180	316488			Bog	Wet; aspen, tamarack, sphagnum, sedges
39	5611036	316402			Bog	Wet; tamarack, sphagnum, sedges
40	5610859	316390			Bog	Wet; sphagnum, willows, aspen

and effectiveness of this watershed is also demonstrated by the westerly water current in the channel draining the western catchment basin into Maskwa Creek in vicinity of samples 1, 2 and 3, whereas the eastern basin drains into Cat Creek mainly via a northeast-flowing creek in the vicinity of samples 15 and 16 (Figure GS-16-2). The tight constraints on the outline and size of the water-catchment basins and the easy identification of the drainage channels make this area an ideal test site for a method in which the recognition of surficial-water flow patterns is of crucial importance.

This survey identified three anomalous humus sample clusters (Figure GS-16-2). For the purposes of this discussion, sample clusters are defined by the occurrence of at least two semicontiguous to contiguous samples containing Pd in excess of the minimum detection limit (0.5 ppb).

Western anomaly

The most prominent sample cluster (samples 1, 2 and 3), both in number of contiguous anomalous samples and in overall Pd concentrations, straddles the western outflow of the western water-catchment area. Sample 1 was collected from the edge of a 1–2 m wide, 1 m deep channel filled with slowly but distinctively westward flowing water. Samples 2 and 3 were collected from a waterlogged bog that is assumed to also drain westward into Maskwa Creek. Palladium concentrations here are significantly higher than in most samples collected during this study. The origin of the anomalous Pd in these samples is unknown, but invites speculation that the source must be located within rocks underlying and/or surrounding this basin. The tightly constrained outline and extent of the western catchment basin restricts the potential source of the mineralization to the outcrops underlying the southern (gabbroic) and northern (anorthositic) ridges west of the watershed. Based on these considerations, it is suggested that the northern and southern ridges along the western catchment basin are an attractive, underexplored target for PGE mineralization.

Southern anomalous samples

Samples 28 and 32, which are separated by approximately 750 m, contained slightly elevated Pd concentrations. The southern series of samples (18 to 33) was collected to detect potential PGE sources in gabbro underlying part of the surrounding outcrops. The source of these anomalous values in humus is unknown. It is suggested that this terrain be explored for sulphide mineralization using geophysical surveys and, given the abundance of outcrops, by prospecting.

Southeastern anomalous samples

The source of this distinct and consistent anomaly, including three contiguous samples (21, 22 and 23), is likely the Hititrite (Theyer, 1986) base-metal and PGE prospect. These samples were collected in a bog adjacent to the ridge that underlies this mineral prospect. It might be worthwhile to further explore the outcrops in the vicinity.

Central anomalous sample

An isolated sample (4) adjacent to a series of exposures, created several years ago by stripping the glacial cover using backhoes and pressure washing, may indicate a currently unknown source of mineralization.

Mayville prospect and M2 anomaly

None of the humus samples collected in the northeast showed any indication of the existence of Mayville mineral prospect (Theyer, 1986). This fact is exacerbated by the recent identification of a major, 1.4 km long, airborne geophysical anomaly (Figure GS-16-2, anomaly M2) generated by massive sulphide mineralization that is currently being defined by Mustang Minerals Corp. (Mustang Minerals Corp., 2005).

Conclusions

Humus sampling successfully outlined several anomalous areas that merit follow-up. The method failed, however, to give any indication of a major body of massive sulphide mineralization. It is suggested that the method has some use in delineating potential exploration targets but should only be used as a preliminary tool in conjunction with other complementary exploration tools.

Economic considerations

Precision analysis of humus samples is a valid method for investigating the PGE potential of mafic-ultramafic rocks in formerly glaciated terrain. Selection of sample sites and the final interpretation of results are crucially dependent on a sound knowledge of the topography and drainage patterns of surficial water.

Acknowledgments

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